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[OFFICIAL NOTICE.]

Fifth Annual Meeting, Pacific Coast Gas Association.

PACIFIC COAST GAS ASSOCIATION.
OFFICE OF THE SECRETARY,
OAKLAND, CAL., June 4th, 1897.

The fifth annual meeting of the Pacific Coast Gas Association will be held at San Francisco, Tuesday and Wednesday, July 20th and 21st, 1897, at 10 o'clock, A.M., in the office building of the San Francisco Gas and Electric Company.

A meeting of the Board of Directors will be held on Monday, July 19th, at 8 P.M., at headquarters in same building.

The following papers will be read and discussed during the sessions:

The President's Address, by Mr. T. R. Parker, Napa, Cal.

"Spontaneous Ignition of Coal," by Mr. John L. Howard, San Francisco.

"Reminiscences," by Mr. F. H. Eichbaum, San Francisco.

"Value of Small Gas Bills," by Mr. W. W. Gillespie, San Francisco.

"From Coal Gas to Natural Gas," by Mr. John Kempf, Jr., Salt Lake City, Utah.

"Small Lighting Plants and their Management," by Mr. Thos. D. Petch, Eureka, Cal.

"Practical Suggestions," by Mr. Chas. E. Burrows, Walla Walla, Wash.

"Uniformity of Accounts," by Mr. C. O. G. Miller, San Francisco.

"Municipal Control," by Mr. C. W. Quilty, San Jose.

"A Short History of a Long Life," by Mr. C. M. Converse, San Francisco.

"Recuperative Benches for Coke and Coal Firing," by Mr. D. R. Russell, St. Louis, Mo.

"Card Bookkeeping," by Mr. V. Stow, San Francisco.

"Gas as Fuel," by Mr. F. Foveaux, San Francisco.

Questions received will be assigned to members for reply.

The "Experience" Department, edited by Mr. John Clement, of Red Bluff, Cal., and the "Wrinkle" Department, edited by Mr. M. C. Osborn, of San Diego, Cal., will make report.

All gas men sojourning in San Francisco at the time of the meeting are cordially invited to be present and to participate in discussions. The Secretary will at all times cheerfully answer any questions and furnish information concerning the meeting, hotel accommodations, etc.

Thursday, July 22d, 1897, will be the outing day for members, their families and friends. A trip on the world-famed scenic railway to the top of Mount Tamalpais will be made, and luncheon served at the "Tavern of Tamalpais." From San Francisco to the mountain top there is revealed the grandest panorama of ocean, cities, towns, bays, valleys and mountains in the world, the view reaching from the snow-capped Sierras to 60 miles from the Marin county shores on the Pacific. The usual banquet will be held on Tuesday evening, July 20th.

Eastern members, and others from the Eastern States intending to visit San Francisco, are requested to advise the Secretary in advance.

JOHN A. BRITTON, Secretary.

BRIEFLY TOLD.

THE MEETING OF THE PACIFIC COAST GAS ASSOCIATION.—Next week the fifth annual meeting of the Pacific Coast Gas Association will be held in San Francisco, and if successful prophecy can be based on present appearances, the latter all point to the prediction that the fifth assembling of the Coast gas men will be the most important and fruitful convention yet held by the Association; nor in this prediction is there any belittling of the valuable meetings that go to make up the Coast Association's history. President Parker, Secretary Britton, Editors Clement and Osborn, and the Board of Directors have evidently worked in nice harmony, for the advance outcome of their labors is a programme that really cannot be excelled from a technical point of view. Our official notice lists, besides the President's address, no less than 12 papers—unofficially, we understand that two papers in addition to those named will be read—with the "Wrinkle" and "Experience" departments, and the Question Box as well, as fortifiers of the technical programme. One "Easterner"—Mr. D. R. Russell, of St. Louis—is a contributor to the paper list, and that brisk gentleman is sure to have something of practical moment to say in his disquisition on "Recuperative Benches for Coke and Coal Firing." Another paper that we look forward to with much interest is that by Mr. Thomas D. Petch, who is to write something about "Small Lighting Plants and their Management;" for much as we admire the cleverness that controls and directs the management of the huge gas plants that cater to the needs of the populous centers of the country, we also have clearly in view that the one who manages the smaller plant has very much more to perplex him than has his contemporary of the greater plan and scope. Then, too, for the one "big fellow" there are six of the "little lads." The programme as arranged, in the order of business, is about like this: On the first day (July 20), the President's address, the regular order of the paper list, routine business connected with the government of the Association and the Question Box; second day, the Wrinkle and Experience departments and banquet; third day, the magnificent panoramic trip to the summit of Mount Tamalpais, the itinerary of which also includes a luncheon at the justly celebrated Tavern of Tamalpais—a programme sufficiently varied to appeal to the tastes of all who will share in the sessions of the Association. The place of meeting is to be in the handsome new office building of the San Francisco Gas and Electric Company, and it has been arranged to hold two business sessions each day—the first, at 10 A.M., with recess about 1 for luncheon; the second, at 2 P.M. Our advices go to show that quite a number of the fraternity from this side of the Rockies will attend the Coast meeting, a complete account of the proceedings of which will be printed in the JOURNAL.

NOTES.—A very complete display of gas engines, by the proprietors of the Otto gas engine works, of Philadelphia, is one of the most interesting features of the Tennessee Centennial Exhibition. Seven different sizes of engines, ranging from 3 to 45-horse power, and in complete running order, are shown. The examples illustrate all types of engines—stationary, marine and portable—built by the proprietors of the Otto gas engine works.——The attention of the orators who favor the plan and principle that lighting plants should be operated on municipal account is called to an item (on page 54) which declares that "the Trustees of the Wheeling (W. Va.) municipal gas plant have determined to increase the illuminating value of the gas supplied, from 16½ candles as heretofore, to 20 candles hereafter." The aforesaid orators usually "point with emphasis" to the fact that under municipal control Wheeling is supplied with gas at 75 cents per 1,000 cubic feet, whereas gas in New York (under private ownership of the works) is $1.20 per 1,000. They are (we presume under the conviction that there is not much sense in "being more Catholic than the Pope") diplomatically dumb over the point that the illuminating value of the Wheeling article is one thing, while the illuminating value of the New York article is decidedly another thing. In fact, we have no doubt that, guaranteeing them their present output as a surety for the future, and with cost of materials and labor equal to those ruling at Wheeling, the New York city Companies would willingly supply in their districts gas of the Wheeling sort at a sensible cut in the Wheeling rate of 75 cents.——The Governor of Massachusetts and his Executive Council should be congratulated over the discretion and wisdom displayed by him and them in the re-appointment and confirmation of Mr. Charles H. Gifford, of New Bedford, Mass., to succeed himself as a member of the Board of Gas and Electric Light Commissioners.——At the annual meeting of the shareholders in the Burlington (Vt.) Gas Light Company no change was made in the former Board of Directors.

The Theory of the Atmospheric Burner, and Its Influence Upon Incandescent Gas Lighting.

[A lecture delivered by Prof. Vivian B. Lewes, F.I.C., Chief Gas Examiner to the City of London, before the Thirty-fourth Meeting of the Incorporated Gas Institute.]

In the historical researches which led to the discovery of the principle of the miner's safety lamp, Sir Humphry Davy noticed that if ethylene or other gaseous hydrocarbon capable of burning with a luminous flame was allowed to escape from a jet placed a few inches below a piece of iron wire gauze, and was then ignited above the gauze, the flame was no longer luminous, and deposited no carbon upon substances held in it. As years passed by, and coal gas asserted its position, not only as an illuminant, but also to a limited extent for heating purposes, Davy's observation was remembered, and some clumsy attempts were made to utilize it in creating from coal gas a heating flame, which should be free from the drawback of blackening the vessels heated in it. For scientific work, these early burners were warmly welcomed, in spite of their many failings, because, bad as they were, they yet had many advantages over the spirit lamp, charcoal furnace and oil lamp upon which the chemist up to that time had been dependent.

It was at this epoch that Bunsen, the greatest of Heidelberg's great men, was planning and fitting those laboratories which have since then given so rich a harvest to the scientific world; and while considering the methods of heating which should be adopted on the working benches, his attention was called by one of his assistants—now Sir Henry Roscoe—to the then novel contrivance of a non-luminous gas burner. Seeing at a glance the enormous convenience of such a source of heat, Bunsen brought his marvellous manipulative skill to bear upon the subject, and in a few weeks gave the world its "Bunsen burner"—a burner which has done more for the gas industry in the past decade than almost any discovery or invention connected with it, which has made coal gas possible and successful for fuel purposes, and has enabled it, in conjunction with the incandescent mantle, to hold its own against the threatened rivalry of the electric light.

The names of Davy, Bunsen and Roscoe will always awaken in the mind a long list of the benefits which their labors have conferred upon the world; but, for practical utility, the simple "atmospheric burner" will always remain one of the most successful achievements to be placed to their credit. Starting from the simple forms left to us by Bunsen, the skilled craft of such masters of the trade as Fletcher has given us convenient modifications in form for endless uses; while the utilization of the atmospheric burner as the heat supply for the incandescent mantle has, during the last few years, given rise to many alterations and some improvements in producing the non-luminous flame in the most effective form.

Notwithstanding the enormous amount of work which has been done in this direction, and the universal employment of the atmospheric burner, there still exists a considerable amount of misconception as to the causes which lead to non-luminosity, and which govern its efficiency for the purposes for which it is employed. In Davy's original experiment with the wire gauze, and in the earlier forms of burner, it is manifest that it is the mixture of air with the coal gas before combustion takes place that causes the luminosity; while in the Bunsen form of the burner, it is only necessary to close the air supply holes to prove the same thing. This form of burner, in one or other of its modifications, is the one most commonly used for incandescent lighting; and the method by which the mixture of air with the gas before combustion is brought about is simplicity itself. A small jet or series of orifices discharge the coal gas into a small chamber surmounted by the upright burner tube; and either the chamber or the base of the tube is perforated with an opening or openings in connection with the air. When the gas tap is opened, the coal gas is discharged through the jet with a velocity which is dependent upon the pressure of the supply, and instead of escaping by the lateral holes it rushes upwards, dragging with it some of the air in contact with the stream of gas; so that as the mixture of gas and air passes up the tube, the pressure at the base of the tube is decreased, and more air is sucked in through the lateral orifices to re-establish equilibrium, and the formation of the mixture in the tube goes on as long as the gas continues to flow.

It is evident that in this way the stream of gas acts similarly to the steam in a Giffard's injector, or the air in a lady's spray bottle; and the chief difference between a good and a bad burner depends upon so regulating the size of the gas and air orifices as to bring about the required combustion at the top of the burner tube. A glance round any large laboratory reveals the fact that this is by no means generally at-

tained; some burners giving a large loose flame with a luminous tip that marks too large an excess of gas, while others burn fiercely, show a tendency to "roar," and after a time flash back down the tube and ignite the gas as it issues from the jet at the bottom—symptoms marking an excessive air supply. In order to check as far as possible the variations, which are to a certain extent dependent upon the pressure of the gas supply, a sliding ring is placed around the lateral air holes; and this, being pierced with holes coinciding only in one position with those in the burner, can be used to diminish the volume of air by being moved round, and so forms a regulator.

Having now obtained a clear idea of the general construction of the burner, it will be well to see why the Bunsen flame should be non luminous. It is manifest, from the construction and use of the atmospheric burner, that the primary cause of its non-luminosity is the admixture of air with the coal gas before combustion; and the idea that this acted by the atmospheric oxygen burning up the hydrocarbons in the coal gas before they could decompose and so liberate carbon in the solid state by which its incandescence would emit light, was the universally accepted theory up to twenty years ago, and still is the one most generally held by the unscientific public, and even by many burner makers. Atmospheric air consisting mainly of a mixture of 79.1 per cent. of nitrogen with 20.9 per cent. of oxygen, and the inert nitrogen playing no part in the ordinary processes of combustion, it was natural that the idea should be accepted that it was the oxygen only which was responsible for the de-illumination of the flame; and it was not until Knapp and others showed that a gas flame could have its luminosity destroyed by mixing the gas before combustion with such inert diluents as nitrogen, carbon dioxide, and steam, that the possibility of the nitrogen in air playing any part in rendering the atmospheric burner flame non-luminous was entertained.

Researches made by Blochmann, Landolt, Heumann, and others, showed clearly that nitrogen did play an important part in this action; and attempts have been made to determine the relative importance of the oxygen and nitrogen in the action which leads to non-luminosity. In these experiments, a Bunsen fitted with two supply pipes leading into the chamber at the foot of the upright tube was used; each pipe being connected with a small meter, which was from time to time checked with a standard meter, so that the flow of gas and air could be accurately regulated and measured. Working with this arrangement the quantity of air necessary to render the flame non-luminous was first determined—6 volumes of gas required 13.5 volumes of air. Now, 13.5 volumes of air contain roughly 2.7 volumes of oxygen and 10.8 volumes of nitrogen. On passing coal gas and nitrogen through the burner, at the rate of 6 volumes of coal gas to 10.8 volumes of nitrogen, a flame was obtained which had only a faintly luminous tip; while on passing coal gas as before, at the rate of 6 volumes to 2.7 volumes of oxygen, a luminous flame is produced, which flashes back unless the tube is covered with fine wire gauze.

This experiment was repeated on the photometer, and it was found that a Bunsen burning gas alone (5 cubic feet per hour) gave a light of 5.6 candle power; one burning 5 cubic feet of gas and 2.2 cubic feet of oxygen, 3.1-candle power; while one burning 5 cubic feet of gas and 9 cubic feet of nitrogen, gave a result which was not readable. It appeared from this experiment that the amount of oxygen in the volume of air necessary to destroy luminosity does less than one-half the work; and the effect of varying the amount of oxygen was then tried, with the following results:

	Candle Power.
5 cubic feet of gas alone gave	5.6
5 " " to 1.1 cubic foot of oxygen	5.4
5 " " 1.5 " "	8.0
5 " " 2.2 " "	3.1 (gauze used)
5 " " 2.5 " "	0.0 "

The amount of nitrogen present in the volume of air required to render the flame non-luminous, as shown above, just fell short of the quantity necessary to bring about the same effect by dilution only; and in order to determine the volume required to entirely destroy luminosity, coal gas was burnt at the rate of 6.2 cubic feet per hour, and was supplied with pure nitrogen, which had to pass at the rate of 14.2 cubic feet per hour before all luminosity disappeared, or practically the same amount of nitrogen is required as of air.

1 vol. of gas required 2.30 vols. of nitrogen.
1 " " 2.27 " air.

At first sight it seemed from this result as if the oxygen of the air really only acted in the same way as the nitrogen—as a diluent. But if this were so, then mixtures of oxygen and nitrogen, richer in oxygen than air, should only affect the luminosity to about the same extent as air. This was not the case, as is shown by the following results:

Volumes of Varying Mixtures of Nitrogen and Oxygen Required to Render One Volume of Coal Gas Non-Luminous in a Bunsen Burner.

Gas.	Vol. of Mixture required.	Composition of Mixture. Nitrogen.		Oxygen.	Vol. of Oxygen Present in Amount Required.
1 vol. requires	2.30	of 1	to	nil	nil
1 "	2.30	" 5	"	1	0.38
1 "	2.27	" 4	"	1	0.45
1 "	2.02	" 3	"	1	0.50
1 "	1.49	" 2	"	1	0.50
1 "	1.00	" 1	"	1	0.50
1 "	0.50	" nil	"	1	0.50

This set of experiments showed very beautifully that until the percentage of oxygen reached the amount present in the atmosphere, the diluting influence of the nitrogen was so strong that it prevented the oxygen having any practical effect in the destruction of the luminosity, but that as soon as the quantity of oxygen present had risen above 25 per cent. its activity had so far overcome the diluting influence of the nitrogen that the matter had ceased to exercise any retarding influence over it.

In almost every laboratory, it may be noticed that whereas most of the Bunsens are burning with their normal blue noiseless combustion, some one or two are roaring, and burning with a sharply-defined green center. Experiment shows that this is brought about by the gas delivery jet having become partly stopped up, and that a far larger supply of air than is necessary to cause non-luminosity is being sucked in.

Ratio of Gas to Air in Blue and Green Non-Luminous Combustion.

Blue	1 vol. of gas to 2.27 of air.
Green	1 " " 3.37 "

The green center shows, therefore, that a large excess of air is passing in; and such a flame is on the point of flashing back in the burner, and lighting at the bottom. In this case the kind of action taking place in the flame has undergone considerable reduction; the flame being fiercer and smaller than in the normal combustion. The change is due to the fact that the proportion of oxygen to coal gas in the mixture is such that the chemical activity of the oxygen is able to overcome the diluting and cooling action of the nitrogen, so that the latter has practically ceased to act.

The volume of the various gases required to render the Bunsen flame non-luminous was carefully determined; the number being limited by having to use a wet meter for their measurement.

Volumes of Gases Required to Render One Volume of Coal Gas Non-Luminous.

1 vol. of gas requires	0.50	vols. of	oxygen.
1 " "	1.26	"	carbon dioxide.
1 " "	2.27	"	air.
1 " "	2.30	"	nitrogen.
1 " "	5.11	"	carbon monoxide.
1 " "	12.40	"	hydrogen.

These figures show that a diluent which burns and increases the general temperature of the flame must be added in far greater quantity than an inert and non-combustible diluent such as nitrogen—a result fully borne out by experience.

Some observers have attributed the varying effects of diluents to the effect of density;[1] but the destruction of luminosity in a flame can be brought about by cooling as well as by dilution, as is well-known in the experiment described by Heumann, who noticed that, if a luminous flame was made to spread itself out over a cold surface, luminosity was destroyed, but could be restored by heating the substance over which the flame was playing. From this it was evident that, if one diluent had the power of extracting more heat from the flame than another, it would be more active in reducing the luminosity, and a smaller quantity would be required to render the flame non-luminous. On comparing the specific heats of equal volumes of the diluents used in the last experiment, the reason for the small quantity of carbon dioxide required was at once seen.

Specific Heats of Equal Volume.

Oxygen	0.2405
Carbon dioxide	0.3307
Nitrogen	0.2370
Air	0.2374
Carbon monoxide	0.2370
Hydrogen	0.2359

1. D. Waldie, "Phil. Mag.," 1838.

If this be the true explanation, it should be easy to trace the action by the decrease in temperature of the flame when carbon dioxide is used to render it non-luminous.

The temperatures of the flames were determined by the Le Chatelier thermo couple—every possible precaution being taken to render them comparable; and though this method has been severely criticized by Professor Smithells, it still remains the best at present at our disposal.

Temperature of Flame from Bunsen Burner, with a Consumption of 6 Cubic Feet of Gas per Hour.

Point in Flame.	Flame Rendered Non-Luminous by Air.	Nitrogen.	Carbon Dioxide.	Luminous Flame from Bunsen.
½ inch above burner...	54°	30°	35°	135°
1½ inches above burner.	175	111	70	421
Tip of inner cone.....	1,000	444	393	913
Center of outer cone....	1,533	999	770	1,328
Side of outer cone level with tip of inner cone	1,333	1,236	970	1,236

These results fully bore out the inferences derived from the behavior of the flame in the former experiments. In the flames rendered non-luminous by diluents, the inner cone for the first 1½ inches is decidedly cooler than in the luminous flame, owing to the cooling action of the nitrogen or carbon dioxide; in the upper portion of the inner cone of the flame rendered non-luminous by air, however, the oxygen of the air is acting, and the temperature is therefore higher than in the luminous flame; while in both the hottest portion of the flame is almost half way between the tip of the inner and outer cones. In flames rendered non-luminous by inert diluents, this is not the case, as the full amount of air necessary for combustion only being obtained at the side and tip of the outer cone, these are the hottest points. The low temperature registered at the tip of a luminous flame is probably due to the impossibility of keeping that portion of the flame steady when the gas is burning from a Bunsen with the air supply closed.

Experiments with a Bunsen burning a mixture of air and coal gas in such proportions as to give the green inner cone showed that, although the excess of air caused a low temperature at the bottom of the inner cone, the increase in rapidity of oxidation due to excess of oxygen produced a rapid rise of temperature, and a hotter and smaller flame was the result.

	Blue Inner Cone.	Greenish Inner Cone.
Tip of inner cone.....	1,090°	1,575°
Center of outer cone.....	1,533°	1,630°
Tip of outer cone.....	1,175°	1,545°
Side of outer cone level with the tip of inner cone.....	1,333°	1,511°

These experiments and the researches of Heumann show that oxidation, dilution and cooling all help to bring about the destruction of luminosity in a Bunsen flame.

In all these experiments, ordinary London coal gas, as supplied by the South Metropolitan Gas Company, was used; but in order to determine how dilution acted towards richer gases, the ordinary gas was enriched up to 24 candles with oil gas, and 43-candle oil gas was also used alone. These gases were then tested in the Bunsen burner at a carefully regulated rate of flow with air, carbon dioxide and nitrogen; and the following figures give the results:

Amount of Diluent Required by One Volume of Gas to Render a Bunsen Flame Non-Luminous.

	Candle Power.	Air.	Nitrogen.	Carbon Dioxide.
Coal gas.....	16.3	2.27	2.30	1.26
Oil gas.....	24.0	5.38	4.20	2.29
"	43.0	7.86	4.71	3.12

These figures reveal the interesting fact that with a rich gas far less nitrogen than air is required to bring about loss of luminosity, on account of the high temperature produced by the combustion of the heavy hydrocarbons with the oxygen in the air. The effect of the inert diluents was also noticeable; as at the point of non-luminosity the flame separated itself ¾-inch from the mouth of the burner, and became very elongated. Either dilution, cooling, or oxidation will render a coal gas flame non-luminous; and all act to a certain extent in the Bunsen flame. But a very important difference exists between the first and last agents; as, when gas has been so diluted as to be rendered non-luminous in its combustion, heating the mixture immediately before combustion restores the luminosity, while if oxidation is the cause, heating has no effect.

As regards the chemical changes taking place in the Bunsen flame, considerable work has been done by Blochmann, Smithells, and myself; and the main changes are far more simple than those to be found in the luminous flame. The gas employed in these experiments was found on analysis to contain:

Hydrogen.....	52.16
Unsaturated hydrocarbons.....	3.50
Saturated hydrocarbons.....	36.25
Carbon monoxide	3.68
Carbon dioxide.....	0.00
Nitrogen...	4.10
Oxygen.....	0.31
Sulphureted hydrogen.....	0.00
	100.00

Such a gas requires 5.5 times its own volume of air for its complete combustion.

In the blue non-luminous combustion of a Bunsen burner, the ratio of air to gas is only 1 : 2.5—*i. e.*, rather less than half the amount necessary to complete combustion; while with the green inner cone of combustion, the ratio of air to gas is 3.37 : 1. It is manifest, therefore, that the Bunsen flame gets from the mixture only roughly one-half the air necessary for its complete combustion—the other portion being obtained from the exterior of the flame during combustion. It is this burning of the gas constituents in two stages that gives the dual character to the flame; the inner cone being due to incomplete combustion at the expense of the previously admixed air, while the outer cone is formed by the combustion of the products of combustion from the inner cone at the expense of the oxygen from the outer air. That this is the case can be beautifully shown by the flame separator devised by Mr. Lewis T. Wright, and elaborated by Professor Smithells, as the two portions of the flame can by its means be widely separated. This dual action is practically completed when the ratio of air to gas is 3.37, and the green inner cone is produced; and taking gas of the composition used in these experiments, the action in the inner cone, when completed as far as the supply of oxygen will allow, would be:

Hydrogen.		Oxygen.		Water.
H_2	+	O	=	H_2O

Ethylene.		Oxygen.		Carbon Monoxide.		Water.		Hydrogen.
C_2H_4	+	O_2	=	2CO	+	H_2O	+	H_2

Methane.		Oxygen.		Carbon Monoxide.		Water.		Hydrogen.
CH_4	+	O_2	=	CO	+	H_2O	+	H_2

The gaseous mixture escaping to burn in the outer cone consists of carbon monoxide and hydrogen in nearly equal proportions, diluted with double the quantity of steam and the residual nitrogen from the air in the mixture. Besides carbon monoxide there is also always found a small quantity of carbon dioxide, probably due to the oxidation of some of the monoxide by the steam present. The gaseous mixture which has now to undergo combustion with oxygen from the external air has a composition approximating to—

Water vapor.....	16
Nitrogen.....	60
Carbon monoxide.....	9
Hydrogen	10
Carbon dioxide.....	5
	100

At first sight, it appears hardly possible that a mixture of this kind, containing less than 20 per cent. of combustible gas, should burn, much less produce the intense heat found in the outer zone of the Bunsen when burning with a green inner zone. As Professor Smithells has pointed out, however, when the flame is burning under ordinary conditions, the outer zone is invariably hotter than the inner, and this is undoubtedly due to the heat from the inner zone of combustion being added to that produced in the outer. When the Bunsen flame is burning quietly with a violet-blue inner cone, the ratio of air to gas is only 2.5 to 1; and under these conditions considerable quantities of methane are found escaping from the inner cone, and burning with the hydrogen and carbon monoxide in the outer. This action is at present causing considerable inconvenience with incandescent mantles.

With the extension of the use of incandescent mantles, several minor troubles, which in the early days of its introduction were thought but little of, have with its extended use become serious drawbacks. Perhaps the most important of these is the frequent carbonization of the top of the mantle, which not only cuts down the illuminating value to a serious extent, but also gives rise to products of incomplete decomposition. At first sight, the reason of this sooty deposit appears clearly manifest; and the observer at once concludes that insufficient air has been mingled with the gas before combustion to render the flame abso-

lutely non-luminous at the tip. On the removal of the carbonized mantle, however, the flame is found to be absolutely non-luminous; and even when the greatest care is exercised in testing all burners to see that they are giving non luminous flames, the trouble still occurs.

If a Bunsen burner be constructed with a platinum tube instead of the ordinary brass one, and if the air supply be so arranged that it burns with a blue non-luminous flame, heating the tube through which the mixture of air and gas is passing renders the flame again luminous, though the luminosity is considerably less than the original luminosity which would be obtained from the gas; and that this is probably due to restoring heat to the flame, is shown by allowing the mixture to cool down before igniting it, when the non-luminous flame is again produced—showing that it really is simply the action of heat, and not any specific alteration in the composition of the gas. If, however, the Bunsen flame is burning with a green inner cone, it is not possible to in this way again render the flame luminous. If, instead of taking a platinum tube, and heating it by means of a blowpipe, the blue non-luminous flame be surrounded with a mantle of platinum gauze open at the top, and so arranged that the sides of the flame impinge upon it in their passage through it, the mantle will quickly be heated to a high temperature, and the top of the flame, which before was non luminous, will now become luminous—the platinum gauze acting as a superheater which gives sufficient heat to the flame to reach the point at which the diluted hydrocarbons escaping from the inner cone become decomposed with separation of carbon. If the platinum gauze be replaced by an ordinary mantle fabric open at the top, the same phenomenon will be observed; and it is this action which leads to the deposition of carbon on the upper portion of mantles.

It will be noticed that the carbon often begins to deposit upon the rod acting as a central support to the mantle; this rod being fixed in a small plate in the center of the burner. The plate really forms a baffle, and above it there is an area wherein there is simply some of the mixture of unburnt gas and air eddying around, which being highly heated by radiation from the walls of the mantle, yields conditions best fitted for the separation of carbon that may still exist in any unconsumed hydrocarbons. When once this carbon begins to form, its catalytic action upon any hydrocarbons still present causes the decomposition to increase in rapidity until both the rod and the upper portion of the mantle become coated to an extent which not only reduces to a minimum the light emitted, but gives rise to distinct traces of carbon monoxide in the products of combustion. This trouble can be avoided by arranging the burner so that the gas should draw in with it the maximum air supply, and should burn with nothing but a green inner cone; and when this limit has been reached (there being no hydrocarbons to be burnt up with decomposition in the outer flame), the carbonizing of the mantle ceases. I think that an outer suspending rod, and a burner which will allow of a mixture of the gas with a maximum amount of air being made without roaring, would entirely do away with this serious disadvantage.

It is manifest, from the results which I have brought before you, that it is imperative, in order to get a proper Bunsen flame for incandescent mantles, that the air drawn in with the gas should be in the ratio of 1 of gas to 3.4 of air, while the ordinary burner, under normal conditions, yields a ratio of 1 to 2½. Moreover, one of the greatest mistakes which has been made with regard to mantle burners, is that the flame with the mantle has been considered as being the same as the flame without the mantle. A moment of consideration will show the fallacy of this. If a burner be arranged so as to give a satisfactory flame, the combustion will be carried on at the expense of about three-fifths of the total air required, which had been previously mixed with the gas, while at least two fifths more have to be obtained from the air; and when the flame is burning unchecked and without a mantle, it obtains this without any trouble. On placing the mantle over the flame, however, the fine network gets rapidly heated to a high temperature, and the condition of the flame will be entirely altered; the inner zone of combustion, at the expense of the previously admixed air, continuing as before, while the products of this incomplete combustion have to find their way through the meshes of the mantle and to burn upon its surface, as the hot mantle will prevent the diffusion inwards of the necessary air to complete the combustion below its surface. In order, therefore, to obtain the necessary conditions for a good burner for this purpose, it is necessary to obtain a mixture richer in air before combustion than with the ordinary burner; and though this is easy to obtain when the gas is under high pressure, the problem offers considerable difficulties when there is only the ordinary town pressure to deal with.

In order to get the necessary maximum of air, the jet by which the gas enters the bottom of the burner must be made as perfect an injector as possible, and this can only be done by using a single aperture of conical form with the opening nicely regulated to the gas consumption required. A number of small apertures, as used in many burners, defeat the purpose for which they were intended. Moreover, the indrawing action of the stream of gas from the injector must be continuous over as long a space as possible; and this is best attained by allowing the gas to suck in the air at different stages in its upflow—a principle which has been adopted in the multiple cone burners made by Chemin and Bandsept—while the size and arrangement of these air orifices require most careful regulation in order to obtain the desired ratio of gas and air.

Yet another point of great importance is to be found in the shape and circumference of the burner head. It is well known that, if an ordinary flat-flame burner be turned on and the gas be allowed to escape unconsumed, more gas will pass through the burner than if the gas be lighted; this being due to the expansion of the gas in the heated head of the burner throwing a back pressure on the gas below. This same phenomenon is to be observed with an ordinary Bunsen burner—*i. e.*, if the straight tube be used with a burner head having the same superficial area as the tube itself, a slight back pressure is created, which upsets the ratio of air drawn in by the gas injector. In order to overcome this the burner head should consist of an inverted cone, the dimensions of which are so arranged that as the mixture of gas and air ascends, the extra space shall be exactly equivalent to the expansion the mixture undergoes. Yet another point that is frequently overlooked is that, as the gas sucks in the air, the mixture formed in the tube is by no means perfect; and it will always be found that the mixture is richer in gas near the center, and richer in air near the sides. This imperfect admixture is to a great extent overcome by the gradual introduction of the air in small portions. But it is important that in the mouth of the burner, immediately before combustion, there should be some arrangement by which perfect admixture is insured; and it is only under conditions such as these that the best results can be attained.

The two burners which aim at producing perfect admixture of gas by these methods are the Chemin and the Bandsept, in both of which successive cones are used. Whereas Bandsept realized the necessity of paying attention to the gas injector and of the inverted cone at the head of the burner, Chemin uses a cone with its apex upwards—an arrangement which, instead of intensifying the uprush of the mixture, as he evidently expected it would, entirely upsets the whole behavior of the burner; and there is no doubt that Bandsept, by embodying these various principles, and using several layers of wire gauze placed at the point immediately before combustion takes place, has given us by far the most valuable Bunsen burner for mantle use that has yet been devised. I have made many experiments with this burner, and find that it gives with mantles of various makes a very high increase in efficiency, amounting in many cases to over 30 per cent.; while, to my great surprise, it seems to prolong rather than shorten the life of the mantle, and after 500 hours shows a far higher percentage gain than during the first few hours.

It will be fresh in the memory of some of the members of the Institute that, at the Edinburgh meeting two years ago, I showed a Denayrouze burner as it was then made, in which, by using a small electric motor, the gas and air were thoroughly churned together and discharged in a complete state of admixture for combustion; the result being a very high duty from the mantle, and the doing away with the necessity for a chimney. It was found in practice, however, that the electric motor and shortening the life of the mantle were serious drawbacks to its use; and M. Denayrouze has since then brought out a burner specially adapted for high intensity lighting, in which the motor has been done away with. In this burner, with a pressure of 2½ inches, I have obtained, with the Welsbach mantles made for it, a light of 18 candles per cubic foot of gas consumed; no chimney being employed.

It will at once be said that this duty is so little above that to be obtained by the ordinary Welsbach, that the advantage is hardly worth the use of a special burner. But in the Denayrouze burner, the gas consumed, instead of being limited to 5 cubic feet, can be taken at a pressure of 2½ inches to 10 cubic feet; and the total light would therefore be 180 candles. When using a cluster of three of the burners, for a consumption of 27 cubic feet one obtains practically 500 candles; while as the number of burners in the cluster is increased, a small diminution in the service per cubic foot takes place, owing to the fact that the incandescent mantle is not transparent to light in the same way that a flame is, and therefore the larger the number of burners in the cluster the greater will be the loss of light due to this factor. If, however, the same effect were to be attempted with the ordinary Wels-

bach mantles, not only would the number of burners have to be very largely increased owing to the limit in the consumption of gas, but each mantle being fitted with a glass an enormous loss of light would ensue, owing to the loss of light entailed by their use. Several processes are also under consideration for the production of high intensity lights by means of meachanical contrivances—increasing either the gas or the air pressure. Such high intensity processes as those devised by Greyson de Schodt, Bandsept (the maker of the burner above referred to), and Caton give very intense lights. But my experiments with them not yet being complete, and the burners, owing to the artificial pressure, not being Bunsen burners in the true sense of the word, I prefer to leave the discussion of these systems to a future occasion.

In dealing with the chemical action, I pointed out that the gas which burns on the surface of the mantle and gives it its power of light emis sion, was practically a mixture of equal volumes of carbon monoxide and hydrogen, diluted to a very great extent with residual nitrogen from the air. This at once suggests that water gas alone, burning without any admixture of air, would prove a highly successful method of generating light; and there is no doubt that, when water gas is consumed in a properly constructed burner, even more light can be obtained per cubic foot burnt with a mantle than with coal gas. In spite of the opposition which the idea has always met with in this country, I am perfectly convinced in my own mind that for street lighting water gas with incandescent mantles will be the light of the future—more especially as within the last few months some most remarkable strides have been made in the methods by which water gas is made. Though it will sound to many present like a fairy tale to speak of 77,000 cubic feet of water gas per ton of ordinary gas coke, yet it is a fact I have seen accomplished within the past month by a process introduced by Mr. Dellwik, and which I have carefully tested on a large scale.

The ordinary process of making water gas consists in blowing a fairly deep bed of fuel with air until it is raised to incandescence, and then passing steam through it, when the latter is decomposed by the heated carbon with formation of carbon monoxide and hydrogen. This causes loss of heat; and after a short time the steam has to be cut off, and the fuel again raised to incandescence by the air blast. In performing this cycle of operations, two gaseous mixtures are produced—(1) Producer gas, a mixture of carbon monoxide, carbon dioxide, and the residual nitrogen from the air, this being formed during the process of raising the temperature by the air blast; and (2) water gas made during the process of steaming the incandescent fuel. Working under normal conditions, with an apparatus of the type generally employed, the composition of these gases is as follows:

	Producer Gas.	Water Gas.
Nitrogen	63.64	2.87
Carbon monoxide	29.33	39.98
Carbon dioxide	4.15	5.61
Hydrogen	2.88	51.54
	100.00	100.00

It will be seen from these analyses, that the producer gas only contains 32 per cent. of combustible gas, and in many cases still less, with the result that it is so poor a fuel as to be hardly worth using except in such operations as making carbureted water gas by the Lowe process, where it is employed for raising the temperature of the superheater. In consequence of this, in nearly all cases the producer gas is blown to waste; and this entails an enormous want of fuel. In ordinary practice, it may be taken that for every 1,000 cubic feet of water gas made by the usual process from gas coke, 4,000 cubic feet of producer gas must be made to revive the temperature of the fuel bed; while only 1,000 cubic feet of water gas can then be made before the temperature falls to the point necessary for re-blasting. Now, 1,000 cubic feet of water gas contain 15.07 pounds of carbon; while 4,000 cubic feet of producer gas contain 44.2 pounds. It is manifest, therefore, that in round numbers 60 pounds of carbon are used in order to make 1,000 cubic feet of water gas; the result being that, with a coke containing 87 per cent. of carbon, it is only possible to make 32,480 cubic feet of water gas, and even with good coke the average would not exceed 34,000 cubic feet of water gas per ton.

When carbon is burnt to carbon monoxide, as in the ordinary water gas process, each unit weight of carbon consumed yields 2,400 heat units; while if the carbon be burnt so as to produce carbon dioxide, the heat evolved for the same quantity of carbon burnt is 8,080 units, or 3.37 times as much. In other words, the same quantity of heat is developed for less than one-third the fuel; and instead of each 1,000 cubic feet of water gas requiring the combustion of 44.2 pounds of carbon to again raise the temperature of the coke in the generator to the required point, it would only take 83.1 pounds—*i.e.*, it is possible to make 1,000 cubic feet of water gas with a consumption of 25 to 28 pounds of carbon. It is this principle that has been utilized in the Dellwik plant; and by the special arrangement of generator employed—in which the height of the fuel bed is kept practically constant, and the air blast introduced in such a way as to complete the combustion during the process of blowing—the entire system of water gas making has been reversed, and instead of blowing for 10 minutes and then steaming for from 4 to 5 minutes, as was done in the old procedure, they now blow from 1 to 2 minutes and steam from 7 to 10 minutes, according to the condition of the fuel. The coke used when I tested the plant yielded on analysis:

Carbon	87.56
Moisture	0.54
Ash	11.90
	100.00

The generator, having been filled to its full capacity, was worked continuously for 4½ hours, during which period the results were as follows:

Gas made	19,119 cu. ft.
Number of runs	20
Coke used in generator	4,664 lbs.
Average period of blowing	1¼ min.
Average period of steaming	8 min.

Ratio of gas to coke, 1,000 cubic feet to 24.5 lbs.

To this must be added 20 per cent. more coke used in raising the necessary steam for generator and blower, which makes 1,000 cubic feet to 29.3 lbs. The temperature of the gas in the pipe leading from the scrubber to the holder was 21° C. (69.8° F.); but in the holder it was not appreciably above the air temperature. The clinker from the 20 runs amounted to 33 lbs., and was easily removed.

The value of water gas largely depends upon keeping the percentage of carbon dioxide as low as possible; and 5 per cent. in the unpurified gas may be looked upon as a fair average. But it is well known that the percentage rapidly increases as the temperature of the fuel falls; and it seemed highly probable that the prolonged steaming would yield a gas containing too large a volume of this impurity. In order to carefully check this point, five analyses of the carbon dioxide were taken during the runs, with the following results: 4.9, 4.2, 4.9, 4.6, 4.3—average, 4.58 per cent. Samples of gas from the holder were also taken at intervals during the process of making, and were afterward analyzed, the results being as follows:

	I.	II.	III.
Hydrogen	52.43	50.09	52.16
Carbon monoxide	38.30	39.95	37.50
Carbon dioxide	3.73	5.38	4.08
Oxygen	0.74	1.22	0.24
Nitrogen	3.81	2.77	5.21

For a crude gas, these results must be looked upon as very good.

I also carefully checked the actions that were going on during the process of blowing up the fuel to incandescence, in order to see if the actions claimed as giving rise to the great economy of fuel really took place. Two complete analyses of the "blow" gas were made, with the following results:

	I.	II.
Carbon dioxide	17.9	18.8
Carbon monoxide	1.8	1.0
Nitrogen	78.6	79.5
Oxygen	1.7	0.7

While during the remaining blows, the carbon dioxide only was estimated, and yielded 18.6, 17.6, 18.6, 16.8, 17.7, 16.0, 15.1, 15.2, 17.4, 18.6, 16.1, 18.1 and 16.05 per cent. respectively.

In the ordinary water gas manufacture the ratio of carbon dioxide to carbon monoxide is about 1 to 7, while in the Dellwik process it is on the average of about 12 to 1; showing clearly that the complete combustion claimed by the inventor does in reality take place.

Even with the enormous drawback of making some 4,000 cubic feet of useless producer gas for each 1,000 feet of water gas, the old process proved itself a success where intense temperatures have been required—as in the welding of boiler flues, etc.; and Dellwik's discovery, by which the practically valueless producer gas is done away with, should be of very great commercial value.

One thousand cubic feet of water gas, containing 15 pounds of carbon, are obtained by a total expenditure of 29 pounds of carbon; so that over 51 per cent. of the carbon is obtained in the gaseous form,

while the expenditure of the other 49 per cent. results in the hydrogen of the water gas.

The coke used in the experiments made contained 87.56 per cent. of carbon, or 1,961.3 lbs. per ton—equal to 15,846,304 thermal units (°C.); and this amount yielded 77,241 cubic feet of water gas. The specific gravity of the water gas, as taken by the Lux balance, was .5365, and its gross calorific value, as determined in Junker's calorimeter, was 4,089 thermal units. Hence the calorific value of the water gas from a ton of coke was 13,033,059.8 thermal units, or over 82 per cent. of the heating value of the total coke used in both generator and boiler.

From this calculation, 20 per cent. of the coke has been taken as used for raising steam; but in a large installation this figure could be reduced, and the percentage of the total heating value of the coke obtained in the gas slightly raised. The labor needed will be less than with the ordinany process, as less fuel has to be handled.

During the next decade we shall probably see many new and start ling improvements in the generation of light; but it will indeed be a red-letter day in the history of commercial success if a combination more important than the Bunsen burner and the incandescent mantle is pressed into improved work and giving us more light.

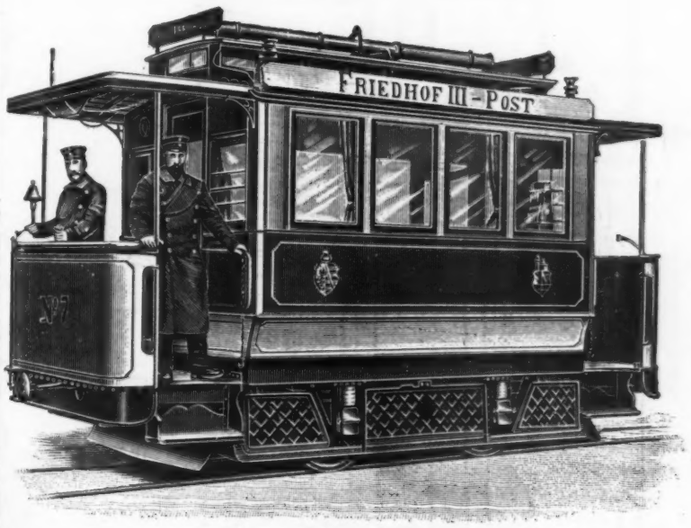
[Prepared for the JOURNAL.]

The Gas Railroad.

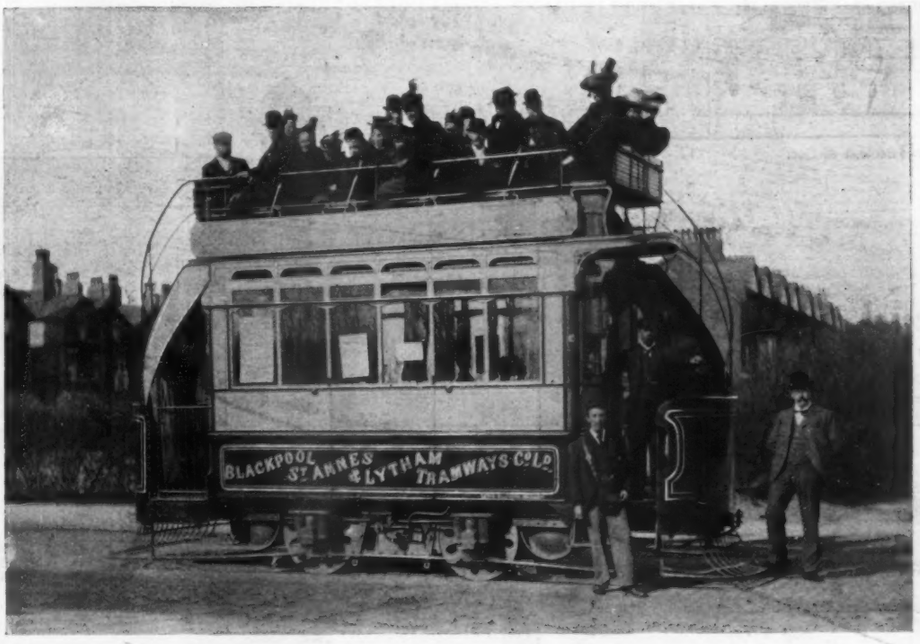
By Mr. FREDERICK EGNER, of Norfolk, Va.

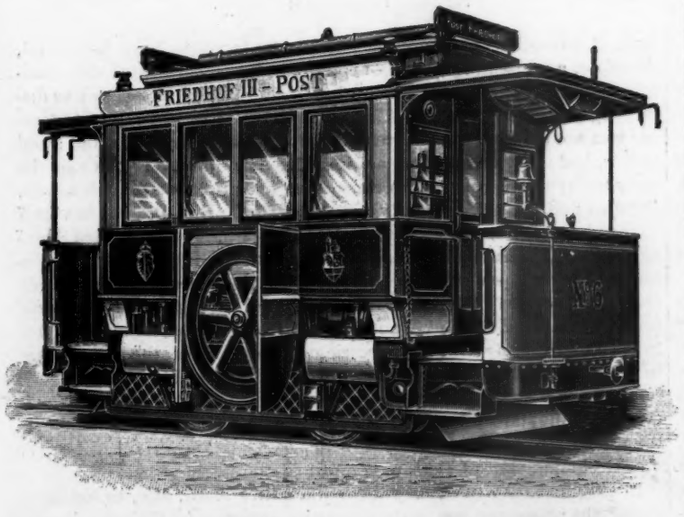
That ordinary illuminating gas can be used to furnish the most economical means of propulsion for street railways is hardly known among professional gas men, hence it is not to be wondered at that the general public is not aware of the fact. Perhaps the following account of recent observations in the line of gas traction may aid in spreading this useful knowledge.

Comparatively few readers of the AMERICAN GAS LIGHT JOURNAL are acquainted with the story of the trial and failure of "The Connelly Gas Locomotive." Tens of thousands of dollars were expended by the Connellys and their friends in their attempts to bring out that worthy invention, yet the latest account (from one of the principals in the attempt) which the writer had of that venture was that he could have the small locomotive, which seemed to work quite well in switching cars at the Third Avenue Railroad sheds in New York City, in the fall of 1894, at half price. It was, however, not to be expected that the gas locomotive should be successful at the very start; in fact, any more so than the early steam locomotives were up to the standard of excellence which we now find in the splendid engines used by most of the great railways on this Continent. If the reader could see the latest improvements in gas traction engines and cars, as shown the writer by Mr. Henry Percy Holt, of Crossley Bros., Ltd., 15 Kensington Court W., London, England (as the author did during the past month of April), or inspect and ride in the still to be improved, though nearly perfect, gas cars now turned out by the "Dessauer Strassenbahn Gesellschaft," he would scarcely be surprised at the failure previously mentioned—

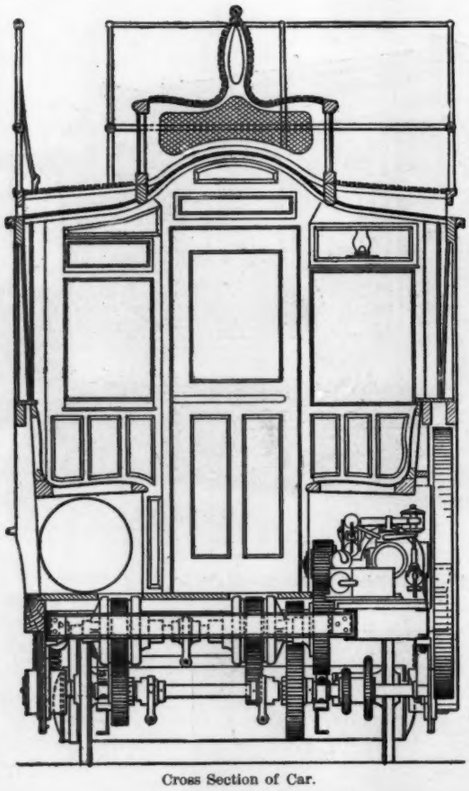


The Other Side of the Car (German Type).

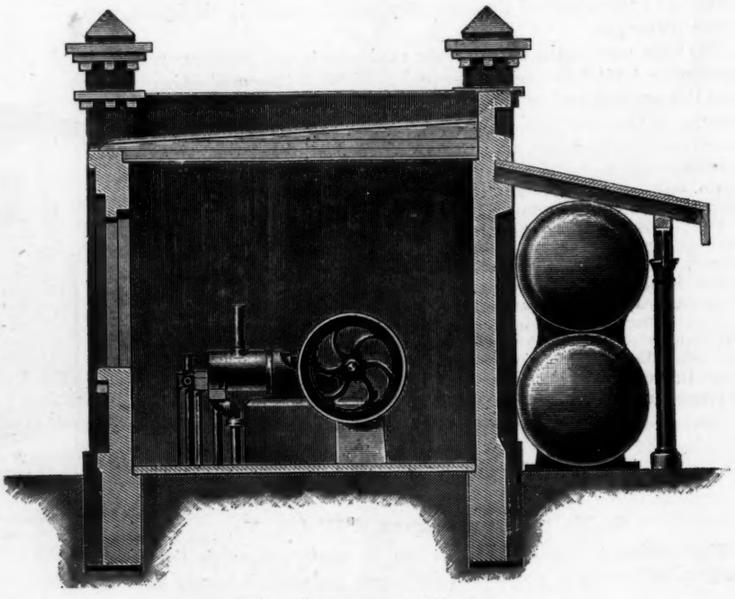




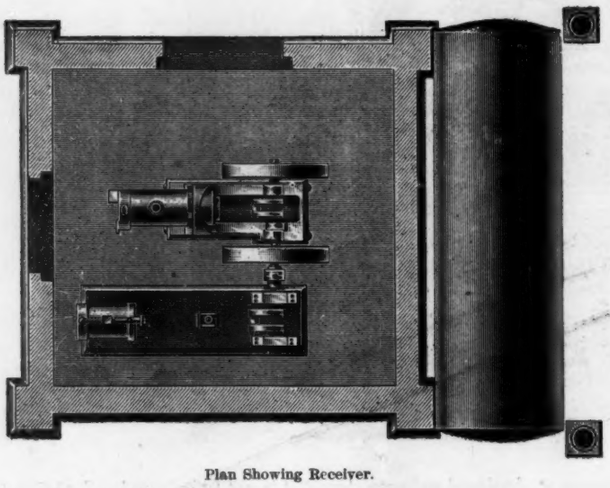
The Car with Side Doors Open, Showing the Motor (German Type).



Cross Section of Car.



Section of Compressor and Receiver.



Plan Showing Receiver.

Section of Compressor and Engine.

though, in the same connection, we should remember that there is more honor in having tried and failed than to never have tried at all. That the people who have so earnestly worked in this country to perfect the gas locomotive may yet reap some benefit from their labors is the sincere wish of the writer of this article.

The annexed illustration, from a photograph of one of the earlier gas motor street cars, as in most successful operation on the Blackpool, Lytham and St. Anne's Tramway, in England, will give the reader an idea of what has been done, but not of what the later greatly improved and larger cars, 12 of which have been ordered for the same line, are like, and which shall be mentioned again later on.

Improvements follow each other rapidly in the construction of this class of cars, so that not even the latest models now used in Germany are to be compared in perfection to the English models soon to be constructed, and of which the working patterns were seen by the writer. The earlier types of gas motor street cars did not recommend themselves to the favor of the traveling public. They contained many imperfections; as, for instance: The car axles were not made strong enough, consequently breakdowns were of occasional occurrence. The ignition of gas in the engines was imperfect, consequently the cars would stop, apparently unaccountably to passengers, at times causing vexatious delays. Connections were not made as perfect as might have been, and, therefore, a nauseating stench of compressed gas permeated the atmosphere within the cars. The running machinery of the cars was distressingly noisy, wherefore, it is small wonder that the gas motor street car was not popular after the novelty of the thing had worn out; add to this, bad management and an insufficient number of cars and the early unfavorable impressions concerning the gas car at its home towns, Dresden and Dessau, are easily accounted for. But all that has been changed. A former superintendent was replaced by the present Manager, Herr F. Hundeshagen, of Dessau; the ignition, previously so faulty, has been perfected, so that now no stoppages whatever occur from that source; the machinery has been strengthened wherever found weak; and the noise and jolting from the machinery are not greater than in any ordinary electric motor car, while the atmosphere in the cars is as inoffensive from noxious odors as that of any other public conveyance. That these improvements could be made was evident from the start, hence the earlier disappointments did not discourage the promotors of the gas motor railway, of whom our friend, Herr W. von Oechelhaueser, of Dessau, is a principal one.

In England they never had these difficulties at all, and, as has been stated, the passenger cars there are quite superior to those used up to

this date in Germany. It was found that this fact was well enough known in some quarters in the German cities mentioned, and that that was one of the grounds of complaint against the Dessau Company. This may be news to the Dessau Company, but the author knows it to be true, from personal information obtained on the spot.

The regular running of gas motor cars commenced at Dresden, in July, 1894. The Dessau Street Car Company was organized March 2d, 1894, and the intention was to use electricity as the motive power, but because of the much lower cost of installation the gas motor plan was adopted, and it was demonstrated to be so desirable in all respects that it was continued and is now being greatly enlarged.

From copies of illustrations furnished, the construction of the German cars may be seen; also, the compressing station. The compressing pumps are driven by a gas engine, which also furnishes power to drive a small dynamo used to charge the storage batteries which are employed as the igniting mediums for the gas motors of the cars.

Although the writer is in possession of a copy of the annual report of the Street Railway Company mentioned, he does not feel at liberty to publish any data contained therein, but can say that the balance sheets show very good net results in favor of said Company. A mere history of the gas cars would be uninteresting to the technical reader unless accompanied by some figures which will give him something to work on. In that connection the following may prove of interest. It was found that self-contained gas motor passenger street cars, carrying about 50 people, would use 2½ cubic feet of gas per horse power per mile run; and this in bad weather and inclusive of the gas used by the compressing engines or lost in any way. Or, to put it this way, 2½ cubic feet of gas per horse power per mile run is the amount of gas to be considered as having to be paid for all told. The gas used in all instances is the ordinary street gas, which, in Europe, seldom reaches 16-candle power. High candle power gas with the corresponding and necessary price (with Welsbach light to fall back on, if high illuminating power is wanted at a minimum cost) is not generally favored in the old country.

The gas car turns corners as easily as any other car does, mounts grades as steep as 1 in 26, are now built to carry enough gas and water for a 25-mile run, and are run at from 7 to 16 miles per hour; but, of course, could be made to run any practical desired speed.

Motors to act the same as locomotives—that is, to be run independently, and not on board of passenger cars—are also used. They possess the advantage common to all gas cars, that but one man is required to handle a gas locomotive, instead of two as with the steam engine. There is no smoke, no sparks to cause fires in passing near combustible matter, they are always ready, and no expensive central power station is required to be constantly in action, as with cable or electric power. Indeed, in connection with electrically equipped street railways, the gas locomotive or self-contained passenger car might prove of decided advantage as an auxiliary of no mean value during hours of light travel, or breakdowns, which fact can be easily understood upon a little reflection. For switching purposes of steam railroads, the gas locomotive, which can be made of any power, would also be a good investment for railroad companies, as it would appear if the assertions of those better posted in the matter are to go unchallenged.

As to first cost of installation for any street railroad, where an ordinarily good roadbed may be had, the gas traction system must recommend itself to the careful, unprejudiced and wise investor, because, in addition to the advantages named for it, its first cost is very much less than that of any other system, as shown by the books of the people who have investigated the subject carefully and then invested their money accordingly, with results now no longer in doubt. As shown, gas for traction is no longer an experiment; but is, like gas for fuel and light, a well established fact. Of what value it may be to established gas manufacturers the writer would not venture to say, but if railway companies could be brought to know these truths they ought to help the cause of gas.

Naphthaline in Modern Gas Manufacture, and the Carbureting of Illuminating Gas.

[Contributed by Messrs. William Young and Thomas Glover, to the Proceedings of the 34th General Meeting, Incorporated Gas Institute.]

Of all the hydrocarbons produced during the carbonizing of coal in the manufacture of illuminating gas, naphthaline has undoubtedly received the greatest attention from those engaged in the industry. This attention has by no means been voluntarily given to it, either through its value as forming a part of the gas or because of its value as a by-product, but mainly on account of the trouble and annoyance it creates by being deposited, as a crystalline solid, in the manufacturing and distributing plant. Of late years those troubles arising from the presence of naphthaline have become more accentuated—due to the fact that the modern system of carbonizing the coal at exceedingly high temperatures leads to an increased production of naphthaline; and the modern system tends to leave diffused or suspended in the gas an increased quantity of the naphthaline present in the products of decomposition, and this has rather been aggravated than benefited by some of the modern systems of enrichment. The authors have been studying the subject in the light of these modern conditions, with the object of arriving at some means of overcoming the difficulties arising from naphthaline deposits; and they have devised certain methods which they believe experience will prove efficacious remedies, and which will also confer other concurrent advantages. The principles upon which these are founded they propose to bring under the notice of the Institute in the present paper.

What Causes Naphthaline Deposits.—The objects aimed at in the modern practice of gas manufacture may be summarized to consist in producing from the coal employed the largest possible volume of gas, possessing the largest sperm value in illuminating power, upon the least possible space. With modern appliances and modes of manipulation, the attainment of those objects involves that the temperature of the heat applied to the retort to carbonize the coal shall be extremely high, so that the constituents of the coal will be cracked up to such an extent that there will be just such a balance between the proportions of the truly gaseous products and of the volatile carbureting hydrocarbons that the latter can be taken up and held by diffusion in the former in the truly gaseous state, at the same time that sufficient condensable liquid hydrocarbons are left to act as a solvent, and prevent the choking up of the manufacturing plant with sooty pitch. It further involves that the condensation shall be so conducted that the denser hydrocarbons, necessarily left to prevent choking, will not be allowed to exercise their solvent affinity for the carbureting hydrocarbons.

It has been found in practice that, while these conditions produce the highest value in pounds of sperm from a given weight of coal, it does not follow that the resulting gas is of the highest illuminating power that can be produced from such coal. Indeed, almost invariably the reverse is found to be the case—so much so that, with the commoner varieties of bituminous coals, the gas is of so low an illuminating power that it cannot be supplied by itself. It has further been found in practice, with the high temperatures employed, that the common varieties of bituminous gas coals, owing to their constitution and molecular structure, are cracked up in such a manner as to leave, so to speak, comparative gaps in the series of hydrocarbons usually found present in the products resulting from the carbonizing of the same coals at lower temperatures. The paraffine hydrocarbons, with the exception of the lower member CH_4, are practically absent, while the easily decomposed creosotes and the higher members of the olefine and benzol groups of hydrocarbons (which have boiling points and vapor tensions approximating to those of naphthaline, and which abundantly accompany naphthaline in the lower temperature products) are present in comparatively small quantities. These appear to be cracked up by the higher temperature heat, and their constituents re-arranged to form the highly stable hydrocarbons, benzol and naphthaline, which stand out prominently among these products.

The altered constitution of the products from such coals, when carbonized at high temperatures, renders it exceedingly difficult to carry out the modern principles of fractional condensation by removing the condensed products from the presence of the gas as they are precipitated. For when the conditions during condensation become such as to lead to the precipitation of the naphthaline, this not being accompanied by a sufficient proportion of liquid hydrocarbons having approximately similar condensing points or vapor tensions, and which can take it up in solution, is necessarily precipitated in a more or less solid form, and causes stoppages. The gas is also left saturated with naphthaline, and, in many cases, even with naphthaline held in mechanical suspension in an extremely fine state of division, gives no end of trouble in the subsequent distribution, due to causes substantially similar to those which produce the trouble in the manufacturing plant, namely, the excessive quantity of naphthaline present in the gas unaccompanied by hydrocarbon vapors which have tensions similar to those of naphthaline; for, owing to naphthaline, on its assuming the solid form, having no solvent affinity for vapors whose tensions are much greater than its own, the presence of benzol vapors does not prevent the naphthaline being deposited in the solid state.

Palliatives, not Remedies.—The remedies—or rather the palliatives—which have been practically employed to overcome those difficulties have been of a two-fold character; both, however, embodying the same chemical and physical principles. The first consists in adding so much

cannel to the common bituminous coal. The cannel coal, owing to its different molecular structure, does not crack up in the same way as common gas coals when carbonized at similar temperatures, but it yields products which, in a sense, fill up the gaps that are left among the products from the common gas coals. The cannels produce a much higher quality of gas and a large quantity of liquid hydrocarbon products, which, while containing a comparatively small percentage of naphthaline, are yet rich in carbureting hydrocarbons, and contain paraffines to such an extent as to make them objectionable from a tar distiller's point of view, and also a large percentage of the higher members of the benzol and other oxygenated hydrocarbons having boiling points and vapor tensions approximating to those of naphthaline. The use of cannel, therefore, more or less, overcomes or palliates the difficulties of carbonizing at high temperatures, according to the quantity employed. It lowers the percentage of naphthaline in the gross products. It supplies an increased quantity of liquid products to take up the naphthaline in solution during condensation, and thus causes the gas to contain less naphthaline—such naphthaline being accompanied by vapors of liquid hydrocarbons having similar boiling points and vapor tensions, which thus lessens or prevent its deposition in the solid form during distribution; and the carbureted hydrocarbon and rich gas from the cannel raise the illuminating power to the extent desired.

The second method of combating the difficulties arising from carbonizing at high temperatures is to conduct the process of condensation so that the condensed liquid products are not removed from contact with the gas as they are precipitated, but are allowed so far to absorb the naphthaline from the gas before they are drawn off as more or less to overcome the difficulties experienced in the manufacturing plant from the presence of the naphthaline. Conducting the condensing process in this manner involves a partial absorption of the illuminants, as well as of the naphthaline, and the gas is consequently of low illuminating power. To overcome this difficulty, the gas is enriched after manufacture in various ways, all of which are well known to the members, and to which it is unnecessary to refer in detail.

It is necessary, however, to point out that in these enrichment processes the enrichers added invariably possess—and designedly so—a very much higher vapor tension than does the naphthaline, and consequently allow the naphthaline to condense out of the gas before they themselves assume the liquid form; and therefore that they mainly modify or prevent the precipitation of naphthaline by their added gaseous volume tending to hold the naphthaline in diffusion. The popular idea that hydrocarbonaceous substances which are soluble in each other yield vapors which also dissolve each other, and thereby help to keep each other in gaseous diffusion, is altogether erroneous. The reverse is the case, for the very same conditions which enable the molecules of a substance to dissolve in each other while in the liquid state tend to keep them in the liquid condition and prevent them assuming or remaining in the vaporous or gaseous state. Coal tar invariably contains volatile hydrocarbons which, when isolated, will volatilise into the gas from which they have been separated during condensation, by reason of the mutual solubility of the volatile hydrocarbons and the denser hydrocarbons present in the tar.

Practical experience has shown that, with modern appliances, the best results in sperm value are obtained by carbonizing coal at so high a temperature that there will be just such a balance between the truly gaseous and the condensable hydrocarbonaceous products that the gaseous portion will be able to take up and hold in diffusion practically all the carbureting hydrocarbons present in the condensable portion; but it is yet questionable if, under all circumstances and conditions, such a system of carbonizing is the most economical. Recent experiences in the production of carbureted water gas prove that a much higher sperm value can be obtained from a given quantity of oil when the gas necessary to take up and hold the hydrocarbons is obtained from some outside source—that is, by the decomposition of water—than can be got from the same oil when cracked up by itself, as is the case with coal, so as to produce by the decomposition of a part of itself the whole of the gases necessary to take up the carbureting hydrocarbons in the residual liquid products.

The Peebles process of fractionally cracking up liquid hydrocarbons of various descriptions has further shown that a still greater gain in sperm value may be obtained from a given quantity of oil by employing a poor gas from some external source—such as water gas or poor coal gas—so as to take up and hold in diffusion the carbureting hydrocarbons as they are formed at the successive stages of the cracking up of the oil. By thus employing an extraneous permanent gas the carbureting hydrocarbons are carried away as formed, and are prevented from being returned to the retort to undergo further decomposition, which would be destructive. It may be instructive to state in this connection that when a gallon of benzol is employed as a carbureting medium diffused through water or poor coal gas it will give an illuminating value of from 2,000 to 5,000 sperm candles, according to the structure of the gas carbureted and the percentage used; but that when the same quantity of benzol is cracked up so as to produce sufficient gas to take up the residue in diffusion, the utmost attainable sperm value is not equal to one-fourth part of that secured when the benzol is employed as a carbureting medium. While, therefore, it may be quite true that a coal may, when carbonized at a medium temperature, yield 8,000 cubic feet of, say, 18-candle gas, equal to 28,800 sperm candles, and the same coal when carbonized at a high temperature may yield 10,000 cubic feet of 16-candle gas, equal to 32,000 candles; yet the tars from the coal distilled at low temperatures might contain such a quantity of carbureting hydrocarbons that, if poor gas from some external source were brought in contact with them, they would confer an enrichment far greater than that necessary to bring up both volume and illuminating power of the mixture to values higher than those of the gas obtained by directly distilling the coal at the high temperature. The carbonizing of the cannel coal along with the common coal, or even in combination with the coal in such a way that their products commingle in the hydraulic main, is undoubtedly a ready and convenient way of overcoming the difficulties arising from high temperatures. There is, however, no doubt that it is wrong in principle.

When the object is to remove the ammonia from the gas, the water produced during the carbonizing of the coal is first allowed to act upon, and become, as far as possible, saturated with ammonia salts; and the required quantity of pure water is subsequently employed to remove, in any of the well known forms of apparatus, the last traces of ammonia. The gas manager would never think of adding the water for the absorption of the ammonia to the products in the hydraulic main, simply because the affinity of the water for the ammonia would be largely modified on commingling with the ammoniacal liquor; and no amount of subsequent contact with the diluted ammoniacal liquor would ever free the gas from ammonia. Now, in a similar manner, when the cannel coal products are commingled with the products from the common coal in the hydraulic main, the power of the cannel coal products to absorb the naphthaline is largely modified by commingling with the very large volume of naphthaline vapors present at this point in the common coal products. On the other hand, the proportionately large quantity of very dense hydrocarbons present in the common coal products absorb from these products part of the carbureting hydrocarbons present therein. Thus a very much larger proportion of cannel coal products are required to perform the double function of absorbing the excess of naphthaline, and of doing the duty of carbureting and bringing up the coal gas to the desired illuminating power, than would be necessary if applied as the water is to the gas to absorb the ammonia.

As has been already explained, the modern system of enriching coal gas by volatile hydrocarbons fails to prevent naphthaline deposits owing to the vapor tension of these hydrocarbons being so much higher than that of naphthaline, that the naphthaline begins to condense out of the gas, in the crystalline solid form, long before the tension of the carbureting vapors is so far reduced as to cause them to assume the liquid condition, and thus to enable them to act as a solvent.

The naphthaline may thus be largely deposited as a solid in one part of the distributing plant, and the carbureting vapors subsequently deposited as a liquid in a more distant part, on the gas being subjected to still lower temperatures.

The Remedy.—These remarks shadow forth the authors' views of the conditions obtaining in existing processes of manufacture bearing upon the naphthaline problem, and indicate the broad principles by which they have been guided in devising means to solve the difficulties arising from the presence of naphthaline. A study of these principles naturally suggested three modes of solving the problem:

1. Modifying the carbonizing and condensing process in such a manner as to avoid the defect referred to.
2. Scrubbing or washing the naphthaline-charged gas, after condensation, by means of a supplementary quantity of hydrocarbon fluid, for the removal of the naphthaline in a manner similar to that by which ammonia is removed from the gas.
3. Carbureting the naphthaline-charged gas with the vapors of a hydrocarbon fluid having vapor tensions approximating to that of the naphthaline, so that when the naphthaline was precipitated from the gas it would be accompanied by a sufficient quantity of liquid hydrocarbon to keep the naphthaline from being deposited in the solid form.

The modifications in the carbonizing and condensing process could be varied according to local conditions; but the guiding principle in all cases would be to carbonize or gasify the coal in two portions. One portion would be carbonized at the high temperature, mainly to produce a volume of gas to take up the carbureting hydrocarbons from a second portion carbonized at a lower temperature to produce products practically free from naphthaline, and rich in carbureting hydrocarbons, so as to remove the naphthaline from the high temperature gas and raise its illuminating power.

Under conditions where bituminous coal was low in price, and in which the resulting coke could be easily disposed of, such coal would be carbonized in the ordinary manner, at a high temperature, to produce a volume of gas. A second quantity of coal of the same or superior quality, or it may be cannel, would be carbonized at a lower temperature, producing gas of high quality, and liquid condensable products practically free from naphthaline. The high temperature gas would be condensed in the usual manner, so as to remove the greater part of the condensable impurities—tar and naphthaline—and thereafter brought into contact, in any convenient manner, with the products resulting from the carbonizing of the coal at the comparatively low temperature. The result would be that the comparatively small quantity of naphthaline present after condensation in the high-temperature gas would be absorbed; and at the same time the high temperature gas would be carbureted and enriched by the products resulting from the coal carbonized at the lower temperature.

The relative proportions of the coals carbonized at the different temperatures would be varied, according to the character of the coals and the quality of the gas required. By thus conducting the process a much smaller quantity of cannel or other coal would be required for enriching and washing the gas than by the ordinary method of carbureting. When, on the other hand, the coals were costly, or the coke difficult of disposal, the coals might be carbonized either in the ordinary retorting or other modified arrangement, but at temperatures that would produce as rich a gas as possible, and a large yield of liquid hydrocarbon products containing little or no naphthaline. A part of the coke resulting from the carbonizing of the coal at the lower temperature, together with the liquid products, would be subsequently employed to produce water gas in a separate apparatus; the carbureted water gas being thereafter brought into contact and washed with the products resulting from the carbonizing of the coal at the lower temperatures. By thus manipulating the process of gasifying the coal a considerable part of the permanent gas required to take up and retain the volatile hydrocarbons in diffusion would be produced by using the residual coke to decompose water; and the hydrocarbonaceous portion of the coal would be conserved and devoted, to a larger extent, to the purpose of conferring illuminating power upon the gas.

It will be further observed that by the adoption of either of these two methods of carbonizing the coal, a better balance may be obtained between the necessary plant and the supply of coal and labor than by the ordinary process. During the period of the minimum demand, in works supplying high grade gas, the retorts could be kept in use, to a large extent, carbonizing at the lower temperature, producing the necessarily small volume of gas of the desired quality, and a large volume of liquid products; these liquid products being stored and worked up during the time of maximum demand in carbureting water gas, involving the minimum of labor and space for the maximum supply. These methods of carbonizing would also offer facilities for carbonizing coal in bulk in large coking chambers, inasmuch as the products, however first evolved, could ultimately be converted into illuminating gas. Both these modified processes would further possess the advantage that the supply of coke and tar could be regulated to the respective demands, and thus prices could to some extent be regulated.

Conditions might obtain in connection with a works where the hydrocarbon necessary to treat the gas produced from coal carbonized at high temperatures (so as to overcome the difficulty arising from the presence of the naphthaline and to raise the illuminating power of the gas) could be more economically obtained from an outside source than by carbonizing a part of the coal at low temperatures. Under such conditions the hydrocarbon fluid could be employed in a similar manner to that described when the low temperature products from the coal are used. The high temperature gases would, in this case, be washed in a limited quantity of liquid hydrocarbon in a suitable scrubber, in the same way that water is used to wash the gas and free it from ammonia. The hydrocarbon liquids which are best suited to this purpose would be those having a high solvent affinity for naphthaline vapor—such as the distillates from coal or oil gas tars, or the oils recovered from blast furnace gases.

In the event of the hydrocarbon liquid being of such a constitution as to render it unsuitable, owing to high density or absence of volatile hydrocarbons, to wash the naphthaline from the gas, it could be first subjected to carbonizing or cracking up at low temperatures; and thus have its constitution altered, and so adapted to treat the high temperature gases, so as to do the joint duty of carbureting and of removing the diffused naphthaline from the gas. Or the washing oils may be purified free from naphthaline held in solution, by being cooled to a low temperature, which would cause the naphthaline to separate as crystals; the oil being thereby rendered fit for use again as a washing agent. If these oils are used for washing purified gas, it might be found necessary to effect their further purification by the use of a limited quantity of caustic soda and sulphuric acid, to remove some of the dissolved sulphur and basic compounds. In washing gas with oils in the manner just described, it would be necessary to exercise due care to see that the temperature of the washing fluid was kept as uniform as possible, and slightly above that of the gas being treated. Fluctuations in temperature, by altering the solvent power of the liquid hydrocarbon and the vapor tensions of the volatile hydrocarbon held in solution, would lead to fluctuations in the illuminating power, on account of the greater or less quantities of volatile hydrocarbon being absorbed from or given up to the gas.

The action of the liquid hydrocarbon, when first brought into contact with the gas, would vary according to its constitution. Should it contain a considerable quantity of volatile hydrocarbons, it would, while taking up the naphthaline vapors, also at the same time part with some of the volatile hydrocarbons to the gas. Should, on the other hand, the liquid hydrocarbon contain a little or no volatile hydrocarbon, then not only would the naphthaline vapor be absorbed from the gas, but so also would the other diffused volatile hydrocarbons be; and this action would continue until a balance obtained between the solvent power of the liquid hydrocarbon and the tension of the hydrocarbon vapor in the presence of the gas. Such a balance of affinities would be soon attained. But in practice it would be better to add to the liquid hydrocarbon, if deficient in such volatile hydrocarbons, the necessary quantity of these before passing it into the washing arrangement; and a convenient method of carbureting would be to add from time to time the necessary carbureting fluid to the scrubbing liquid hydrocarbon. Such addition would not interfere with the dissolving out of the naphthaline, as from the lower vapor tension and the practical freedom of the solvent fluid from naphthaline, that substance would continue to be absorbed while the high vapor tension of the other hydrocarbons leads to its volatilizing into the gas.

On the solvent hydrocarbon liquid becoming so charged with naphthaline that it could no longer dissolve the naphthaline from the gas, it would be drawn off from the scrubbing arrangement and cooled to a low temperature, and the crystallized naphthaline removed by passing through a filter press. Or alternatively, where convenient, the liquid hydrocarbon might be distilled, and the fraction containing the major part of the naphthaline separated, cooled to a low temperature and filtered; the whole distillate being thereafter again mixed. The liquid hydrocarbon, thus freed from naphthaline, would be again returned to the scrubbing arrangement for further use. By thus using the same hydrocarbon fluid over and over again, nothing but the denser vapors of naphthaline and other hydrocarbons could be removed from the gas or lost. The temperature of the absorbent hydrocarbon would be so regulated that the volatile carbureting vapor would either not be absorbed, or, if absorbed, again revolatilized into the gas. Not only so, but by adding volatile liquid hydrocarbons, they would be made to do the double function of washing the naphthaline vapors out of the gas, and thereafter being themselves volatilized into the gas; thereby conferring upon it additional illuminating power.

This process could be very conveniently introduced into works possessing tar distilling plant. The early part of the distillate could be isolated and freed from naphthaline by refrigeration, filtered, and thereafter employed to scrub the gas to absorb from it the naphthaline, and to carburet the gas. On becoming charged with naphthaline, it could either be run from the scrubbing arrangement to the tar well, or returned direct to the still to be distilled, cooled, and again prepared for re-use in scrubbing the gas.

Where the conditions connected with a works are such that neither of the methods which have been just described for dealing with the difficulties arising from the naphthaline deposits can be adopted, a modified carbureting process will be found greatly to reduce, if not completely to remove, those difficulties; for, as already explained, crystalline solid naphthaline deposits only take place from gas when the naphthaline vapors are present in the gas unaccompanied by the

vapors of liquid hydrocarbons having similar vapor tensions. It is therefore evident that, by carbureting naphthaline-charged gas with the vapors of liquid hydrocarbons having similar vapor tensions, whenever the conditions become such as to cause the precipitation of the naphthaline from the gas, the vapor of the liquid hydrocarbon will be simultaneously condensed, and will take up the naphthaline in solution.

It is further evident that, in employing such a process, the quantity of the vapors of the liquid hydrocarbons added to the gas must be carefully adjusted to that necessary to prevent the troubles arising from naphthaline deposits; for whenever the conditions during the distribution of the gas become such as to cause the precipitation of the com bined naphthaline and liquid hydrocarbon vapors, they invariably, owing to their liquid condition and their solvent affinity, take down with them from the gas a portion of the other carbureting vapors. This reduces the luminosity of the gas; and the condensable matters, of course, require to be pumped from the drip traps and returned to the works.

A Speculation Regarding the Cause of Roentgen Rays.

By Mr. Elihu Thomson, in *Electrical World*.

Since so eminent a physicist as Prof. J. J. Thomson has in a recent paper put forward the hypothesis of the breaking down of what we have been accustomed to call the "elements," and has shown a reasonable basis for such a hypothesis, the writer deems it not improper to state that a similar view had quite independently arisen in his own mind, the origin and progress of which may, it is thought, be interesting to others working and thinking in the same field. No apologies are offered for indulgence in the speculations herein presented. They are not presented as scientific theories, demonstrable by appeal to facts, but may possibiy aid in investigation, and they are, therefore, given for what they are worth.

For some years past the writer has felt that some light might be shed upon the nature and relations of the so-called elements could we attain exceedingly high temperatures by any means. The elements may have been evolved in the order of their complexity in a manner similar in some respects to the species of plants and animals.

About four or five years ago an experiment was planned as one possibly capable of permitting temperature far exceeding that of an electric arc, our present limit, to be obtained. A temperature of less than 4,500° C. above absolute zero is not high when it is remembered that there can be no upper limit assigned to possible temperatures. Our chemistry is now all confined, so to speak, within lower limits than 4,000° C. to 5,000° C., and even within these limits most known compounds are decomposed or dissociated. Can we not raise our plane of temperature and give birth to a new chemistry in which the present elements, though apparently stable hitherto, shall become dissociated into simpler forms; for that they are complex is to be inferred from the complex spectra which all, not excepting hydrogen itself, possess?

It was seen that the temperatures attainable by electric means were limited by the volatility and consequent expansion into vapor of the substances subjected to electric current, but that if the expansion could be prevented there might result the possibility of securing indefinitely high temperatures. To do this it was planned that a very strong and thick, but short, cylinder, of tempered steel, should have a small central opening through it so as to make it into a thick tube. This was to be lined with an insulating lining of some simple compound, as magnesia, for example, in a perfectly pure state. A core of wire of, say, metallic magnesium, was to pass through this, after which carefully insulated heads or caps were to be very solidly clamped to cover the ends of the cylinder and form the terminals for the passage of an electric discharge. This would pass from head to head through the central core (wire of magnesium). This discharge was to be that of an enormous condenser charged by alternating currents furnished by a step-up transformer and the amount of energy to be delivered in a fraction of a second was to be made very large. The operation would be nearly instantaneous and should result in enormously high temperature of the material within the steel shell. There could be no expansion to lower the temperature. A spectroscopic examination was to be made of all the materials present before the experiment and a similar examination after the experiment should declare the presence of any element not there before. Reasoning on the idea that many complex compounds arise from sudden heating and cooling of comparatively simple compounds, it was thought possible that if dissociation of elemental forms took place at the enormously high temperatures the cooling would probably give rise to small amounts of the denser elements, discoverable, perhaps, by the spectroscope. These denser elements were to be the "elemental tars" or "polymers" of simple ones subjected to experiment. The experiment was to be varied in many ways. The general proposition was described to several associates at the time it was thought out. Among these are several well known workers, such as C. P. Steinmetz, E. W. Rice, Jr., Robert Shand and others. The plan was recognized as a basis for a possibly fruitful research. There was no opportunity to prepare for the work, and the idea was allowed to rest, in the hope that the future would yield the coveted freedom to undertake it. After two or three years the discovery by Röntgen of the peculiar radiation from the Crookes tube led to the writer's giving considerable time to investigation of the actions occurring, and probably as a consequence of the prior thought in relation to elemental dissociation, the idea came that in the Crookes bombardment stream the conditions, upon collision with the platinum anode, must represent those of an exceedingly high temperature of the gas. With certain exciting apparatus of great power it was found that the bombardment was so energetic as to heat in a few seconds an anode plate 1-16 inch thick and an inch square to intense glowing heat. Considering the small mass of the molecules of gas projected from the cathode, the velocity of their movement was seen to be extremely great if they were to convey the energy delivered in so short a time to the platinum anode. The layer of gas immediately in front of the platinum must, it appeared, reach an extremely high temperature, and represent in a measure the conditions sought for in the proposed experiment with the steel tube above described.

The question arose: Could it be that the increase of vacuum was after all due to the formation out of the gas, of small amounts of denser materials, or even that the elementary gases were decomposed at the high temperature only to reform on cooling but with a small "tarry" residue, so to speak, polymers, perhaps, or denser, non-volatile elements? If this were so, then the gas should eventually all disappear in the same way. It does disappear, but how? We have guessed, but may be mistaken. We need to know more of it.

Considering these matters it occurred to the writer that a cause for the production of Röntgen rays might be found if the elements were dissociated into simple or more primordial matter. Taking the view, which has much to support it, that in the spectrum of ordinary heat and light we find all those rates of electric oscillation which characterize vibrating molecules or the atoms of elements composing them; that they set waves up in the ether because the ether is essentially electromagnetic; that the great rigidity of the ether, so opposed to its apparent extreme mechanical mobility, is after all only a chemical or electromagnetic rigidity, bearing no proportion to its chemical properties, any more than the ordinary fluidity of a chemical compound bears to the chemical stability of the compound, we arrive at an interesting supposition respecting the Röntgen ray emanation. If the residual elementary gases are broken up into simpler and finer matter within the area of the bombarded spot, the normal electro-magnetic rates of vibration of that finer matter should be far higher in pitch or of shorter wave lengths than in the case of the ordinary spectrum. According to this view there would be no oscillation so slow as ordinary light originating in the finer matter dissociated from the elements at the exceedingly high temperatures represented by the colliding molecules or atoms immediately at the front of the platinum anode. All the wave lengths emitted as normal to the new forms of matter, only existent at the highest temperatures, would be of the Röntgen ray order, and a spectrum of such rays might characterize the matter present, as the ordinary spectrum does the low temperature combinations. But absence of diffraction and refraction effects thus far are formidable obstacles to such analysis of these higher pitch rays.

The absence of the lower or Hertzian waves from sunlight probably depends on there existing no molecules or atomic aggregations in ordinary matter which can possibly vibrate electrically at such low rates. So in the hot primordial matter no ordinary light waves need be generated, but only the higher order known as Röntgen rays. The latter are the normal vibrations occurring in such matter. The spectroscope cannot help us in the analysis of these higher waves and the forms of matter giving rise to them. Further, if in the universe some of the hotter nebulæ contain this ultra-elemental matter the eye will not discover it, and the air around the earth is too absorptive for these higher rays to penetrate it and reach us. A "fire mist" of primordial matter must remain invisible until some part cools sufficiently to form aggregations which we call elements, which are, perhaps, only extremely stable forms resembling in stability most of our known compounds at near absolute zero.

Admit the possibility of the view here expressed as a speculation

merely, and it follows that there may be stars so hot interiorly as to possess only an outside layer of elements in the ordinary sense, while farther down within them are the black depths which shine only with the higher rays. Our sun has a low density, and if its interior, not subject to radiation loss, be of very much higher temperature than its exterior cloud of ordinary elements, a rift in the cloud might let out Röntgen rays which would produce electrical disturbances in the earth's outer atmosphere. Again, the mystery of the sun's supply of heat would be in part resolved. The heat given out in the formation of ordinary chemical compounds may be relatively very small compared with that yielded during the condensation of the ultra-elemental matter assumed into ordinary forms called elements under very powerful chemical or electrical forces. One can then conceive of a real photosphere surrounding the sun and begin to understand the meaning of those tremendous outbursts of activity connected with prominences and spots. Ordinary elementary forms arising by combination and cooling in the outer solar layers would precipitate themselves into the hotter dark interior to be violently decomposed, and this would occur over and over again until the interior temperature was too low for it. Should the action become rhythmic we may begin to understand sun spot periods or stellar variability.

These ideas are not scientific in the limited sense; they are the result of imagination allowed free scope in dealing with imperfect data. The whole fabric must stand or give way according to fitness in the light of advancing knowledge of real facts. The history of science and invention shows that progress often depends upon a fortunate leap in the dark, and that no harm can come from consideration of many suggested hypotheses in a field where so little is known. To forewarn is to forearm, even if the final result is to expose a fallacy.

If the writer succeeds in drawing attention more than ever to such a fruitful field of research as the Crookes phenomena furnish he will be satisfied. The conviction cannot be escaped that we have in them the opening of a new era in physical science, an extension of limits, a new chemistry, perhaps.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE following inquiry is referred to Mr. E. H. Jenkins, Superintendent of the Covington (Ky.) Gas Light Company—we add that the gentleman who asks the question asks it in good faith:

PHILA, PA., July 2, 1897.

To the Editors AMERICAN GAS LIGHT JOURNAL: Reading Mr. E. H. Jenkins' valuable paper on "Leakage," read before the Western Gas Association last May, and published in the JOURNAL for June 14th, 1897, I am in doubt over the point where he speaks of correction of temperature being a very important matter.

Will you kindly enlighten me how he arrives at the figures "974 cubic feet," the gas being registered at a temperature of 70° F., the standard for registration being 30 inches barometer and 60° F. Please give solution?—Very truly, INQUIRER.

MR. W. S. RATHELL, Superintendent of the Decatur (Ills.) Light, Heat and Power Company, writing to the JOURNAL under date of June 30th, says: "Acting under the instructions of the Board of Directors, I have let to the Western Gas Construction Company the contract to furnish the necessary material to remodel the Kendall oil gas plant placed in their works some years since. The shells of the old Kendall apparatus will be utilized and the generating plant changed to a double superheater setting, 6 feet in diameter. This will give an apparatus up to a capacity per diem of about 350,000 cubic feet. Anticipating the increase in candle power we are mailing to the residents the following notice: "After September 15th, when improvements on our plant will be completed, if your gas fails to give light equal to that of two incandescent elecric lamps, your fixtures are at fault. Let us know about it. We can remedy the trouble." The prolonged cold weather has been a damper on the gas stove business, but since the thermometer has climbed up around the 90° point we have placed to the credit of our sales department about 75 ranges, which have aided in bringing our daylight consumption up to about 55 per cent. of the entire output.

THE new apparatus for the Ipswich (Mass.) Gas Company will be completed and in use by September 1st—so it is said.

THE authorities of Alexandria, Va., have decided to employ an expert for the purpose of determining what improvements are necessary to put the gas plant (which is owned and operated on municipal account) in shape to manufacture gas for illuminating and fuel purposes in accordance with economical and satisfactory methods.

THE Chicago daily newspapers recently reported that a novel scheme to beat the Chicago Gas Company was explained in the Criminal Court, when A. Summerville was brought to trial before Judge Smith. Defendant was charged by the Chicago Gas Light and Coke Company with fraudently tampering with gas meters. It was stated in Court by the prosecution that Summerville had gone around town representing himself to be a gas fitter. When he found a business man with whom he thought it safe to "negotiate," it is said he would impart the information that he could "fix" the gas meter so as to reduce the expense of the consumption of gas 50 per cent. For this service Summerville's fee was $5. George B. Angelica, a saloon keeper at No. 479 Wabash avenue, thought well of Summerville's proposition, and paid him $5. In Court Angelica testified that defendant's manipulation of the gas meter reduced his gas bill about 30 per cent. The prosecution alleged that Summerville found 17 men in one week who were willing to pay him $5 each to "doctor" their gas meters. Summerville's plan was to puncture the diaphragms. He was convicted.

MESSRS. J. HOWARD NICHOLS, James W. Cumnock and Luther White, Directors of the Chicopee (Mass.) Gas Company have filed the following notice, bearing date of June 30th: "The undersigners, being the Directors of the Chicopee Gas Company, hereby certify that said Company has sold all of its real estate, situated in Chicopee, together with building, apparatus and machinery used for the manufacture of gas, and likewise all of its holders, pipes, mains and meters for the distribution of gas, to the Chicopee Gas Light Company, and has signed and delivered a deed thereof. And the said Directors likewise declare that said Company does likewise surrender and give up all right which it has to lay pipes and mains in the streets of Chicopee. This surrender to be operative whenever similar privilege is granted to the Chicopee Gas Light Company as the successor of said Chicopee Gas Company."

WE understand that the Citizens' Gas and Electric Company, of White Plains, N.Y., has again changed ownership. This time Pennsylvania capitalists are said to be in control.

THE plant and franchises of the Geneva (N. Y.) Gas Light Company have been purchased by Messrs. George T. Duncan, Seth L. Larrabee and E. B. Winslow, of Portland, Me.

THE proprietors of the Consumers Gas Company, of Wilkes-Barre, Pa., have declared a dividend of 3 per cent., out of the earnings for the first half of the year. It is payable on demand.

MR. HOMER MANVIL, of Kalamazoo, Mich., is the main party in interest for the projected gas plant at Holland, Mich.

A QUEERLY based suit for damages is reported from Atlanta, Ga., the papers in which were filed on the 28th of June. The main points in the complaint recite that, on a certain date, John Wright, a laborer in the employ of the Atlanta (Ga.) Gas Light Company, while working in a trench, struck his foot with a pick with which he had been loosening the soil. The injuries received resulted in his death; so it is claimed by his widow. She further avers that had the pick been perfect the accident would not have occurred, since her husband was well versed in the nature of the work he was performing. The sum asked is $5,000.

THE Directors of the Hartford (Conn.) City Gas Light Company have declared a semi-annual dividend of 4 per cent., payable on demand.

THE Boston *Post*, of July 2d, says: "As gasfitters will not be allowed to practice in the business, after October 1st, without licenses, the Board of Examiners for Gasfitters has determined to hold two examinations a week instead of one. Between 10 and 20 applicants are examined each time. All the gasfitters must show in a practical way what they know about their trade, and for this purpose the Board has obtained every kind of pipe and appliances that are likely to be used, so that the practical demonstration may be made before the Board in the rooms of the Board of Health, where the examinations are held—heretofore the candidates have been taken outside for the practical tests. They are required to name and explain the office and purpose of every piece in the collection. Until all the gasfitters that are in the business now have been examined, their certificates made out and their licenses issued, the Board will have much work to do. It takes nearly a whole afternoon to examine a class, and to read and pass upon the papers of

15 or 20 persons is no small task, especially as many of the old gasfitters who may know their business well and understand the questions perfectly, are unable to write their answers readily and legibly. Of course, bad spelling and construction are overlooked in marking the percentage. After October 1st probably only such as are about to begin the trade will have to be examined. If a candidate fails in the examination the first time he has to wait three months for another trial, and if he then does not pass he must wait six months more."

MR. SAMUEL DODD, Treasurer of the Meriden (Conn.) Gas Light Company, denies that any offer for control in the stock of the Company has been made by any syndicate. Our advices, however, go to show that certain people connected with the proposition to secure control of the gas properties at Bridgeport, New Haven, etc., are not adverse to adding Meriden to their holdings—prospective and otherwise.

A CORRESPONDENT at Bristol, R.I., writing to the JOURNAL, under date of the 5th inst., says: "The committee on permanent organization of the Bristol County (R. I.) Gas and Electric Company, reported to the Directors of said Company, at a meeting held at the First National Bank, Bristol, R. I., July 3rd. The number of Directors was increased from 5 to 9. The Board completed is thus composed: Col. Samuel P. Colt, J. H. Manchester, ex-Lieutenant Governor Wardwell and W. R. Bogert, of Bristol; Judge B. M. Bosworth, J. W. Martin and John Waterman, of Warren; L. R. Peck of Barrington, and M. J. Perry, of Providence. The Directors named the following officers: President, Col. Samuel P. Colt; Vice-President, John Waterman; Secretary, Treasurer, and Manager, W. R. Bogert.

THE old contract made by the authorities of Spencer, Mass., with the Spencer Gas Company for the lighting of the streets, expired on the 1st inst. At the town meeting held last April the Selectmen were authorized to contract with the Spencer Gas Company for lighting the streets with arc lamps for one year, from July 1st, "at the average price per light that is paid by other towns in Worcester county." The Selectmen have ascertained that the average price paid by the other towns is about 27 cents, and have directed Mr. H. H. Capen, of the Board, to make a contract with the Company for 70 arc lights, to be lighted 22 nights in every month, at the rate of 27 cents per lamp per night.

ARTICLES incorporating the Wattles Steam and Gas Engine Company have been filed with the Secretary of State of Rhode Island. According to the articles the Company is formed for the purpose of engaging in the business of owning, buying, and selling patent rights for steam engines, gas engines, motors and motor vehicles, and all articles relating to and incidental thereto, for the manufacture and sale of such engines, motors and motor vehicles, for the establishment of manufactories for their production, for granting license to others to manufacture and sell such, and for the transaction of such business as may arise in connection with the foregoing. The amount of capital stock is $100,000, and the incorporators are Henry A. Stearns, Luther H. Wattles, Clarence E. Wadsworth, William B. Sherman and James B. Arnold. The chief place of business is Providence, R. I.

IT can be definitely stated that the syndicate which has been dickering for control in the shares of the New Haven (Conn.) Gas Company has secured a majority of the stock. The price paid was $69 per share (on the par of $25), and the syndicate will take all the stock that is offered at the price bid.

THE proprietors of the Santa Ana (Cal.) Gas and Electric Company have given notice that the rule declaring that "consumers using less than 200 cubic feet of gas per month will be charged 50 cents meter rent," will hereafter be strictly enforced. Heretofore the rule has been honored more by breach than observance, but the increase in the number of parties insisting on having gas meters in their houses, merely to insure them against electric light extinctions, necessitated the enforcing of the rental direction.

A CORRESPONDENT at San Jose, Cal., forwards the following under date of June 18th: "The 9th annual meeting of the San Jose Light and Power Company was held yesterday afternoon. A very large representation of the stockholders was present. The reports of the officers showed a prosperous business for the past year. That the public appreciated the reduction in gas rates is shown by their use of 1,250,000 cubic feet of gas more than was used in 1896. The earnings warranted the declaration of a 6 per cent. dividend and the setting aside of funds equal to paying for the placing of about two miles of gas mains in the outlying districts. The following Directors were elected; Lloyd Tevis, J. K. Prior, Uriah Wood, Amasa Eaton, J. E. Leiter, G. Lion and C. W. Quilty. The Directors on assembling selected the following officers: President, C. W. Quilty; Vice-President, Amasa Eaton; Treasurer, C. T. Ryland; Secretary, J. B. Clark. Much of the increased consumption of gas during the past year is attributed to the rapidly growing use of gas stoves by thrifty housewives, who, at a less cost than with coal or wood, cook food by the most rapid, cheap and scientific method now known, and who, by this use of gas, avoid the stench, inconvenience and danger of explosion of coal oil and gasoline. The San Jose Light and Power Company has on sale, from 75 cents upward, every style and cost of gas stove in its gas stove department, and to every purchaser of a gas stove is presented a copy of Marion Harland's famous cook book, 'How to Cook with Gas.'"

THE plant of the St. Joseph (Mo.) Light and Fuel Company was sold at auction an the 1st inst., as advertised by the Illinois Trust and Savings Bank, the trustee for the mortgage, under foreclosure proceedings. The property was bid in by Mr. C. H. Randle, of Chicago, for $250,000. The consolidation of the gas interests of St. Joseph will now be completed without delay.

THE reappointment of Mr. Charles H. Gifford, of New Bedford, Mass., as a member of the Massachusetts Board of Gas and Electric Light Commissioners, has been confirmed.

A CORRESPONDENT at New London, Conn., forwards the following: "The New London Gas and Electric Company is to be commended over its action in concluding negotiations with Mr. C. A. Williams for the purchase of a plot of land just north of its present site. On this new purchase the Company will construct its holder, which it was purposed to erect on a plot to the west of the railroad track, a plan which they abandoned in deference to the wishes of the owners of adjacent property. The holder is to be of the single lift order, with a capacity of something over 100,000 cubic feet."

THE Trustees of the Wheeling (West Va.) municipal gas plant, have determined to increase the illuminating value of the gas supplied, from 16¼ candles as heretofore, to 20 candles hereafter. Oil will be employed as the enriching medium.

THE Buffalo *Times* says that after six years of existence, the Medina (N. Y.) Gas and Electric Light Company has been consolidated with the Medina Water Works Company, the latter Company in connection with several wealthy men from Rochester and New York having purchased the Electric Light Company. The new corporation will be known as the American Electric Light Gas and Water Works Company. The deal has been in contemplation, but the final consummation was not had until yesterday. Mr. Spencer, of New York, will have full charge of affairs here, he having taken the place of Mr. William R. Curry, who has been the Superintendent and Manager for the past 14 years. The exact sum paid for the plants is not known, but is stated upon good authority to be in the neighborhood of $100,000. The Electric Light and Gas Company, although a paying concern, is mortgaged to the amount of $17,500. In order to escape paying the interest or the mortgage, which is reported to be due, the Company sold out to the Water Works Company and a number of other wealthy men, who are reported to be the mortgagees, thus the mortgage is left standing and no interest accrues. William Ross, President of the Water Works Company, will probably be made the President of the new organization, as he seems to be the real head of the whole concern."

The Reduction in the Cost of Steam Power from 1870 to 1895.

The last meeting of the season of the Association of Mechanical Engineers, of Providence, was held at their rooms in that city the first week in July. A paper upon "The Reduction in the Cost of Steam Power from 1870 to 1895, and the Outlook for the Future," was given by F. W. Dean, of the firm of Dean & Main, of Boston. Twenty-five years ago the most economical steam engine in use in mills was the Corliss simple condensing engine that used 19 or 20 pounds of steam per horse power per hour. Previous to that time compound engines had been used in England in mill practice, and simple engines had in many cases been changed to compound. In this country compound pumping engines had been used to a very limited extent, and the installation of the Morris engine at Lowell and the Leavitt engine at

(*Continued on page* 55.)

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Lynn are notable examples of them in the early part of the period that we are considering. The Pawtucket, R. I., pumping engine, which was started on June 30, 1878, is another important example of economical pumping engines, and probably was the most economical engine that had been built up to that time.

While these engines are not mill engines, they influence the practice of builders of mill engines and can properly be considered with them. Pumping engines have always been the leaders in economy, but at the present time the best pumping and mill engines are practically equally economical. At the present time we may cite the Louisville pumping engine and some two or three mill engines, as at Grosvenordale, Conn.; Natick, R. I.; West Boylston, Mass., and Berkeley, R. I., as being almost on a par. It is now as easy to design an engine to use less than 13 pounds of feed water per horse power per hour as it was to get down to 16 pounds in 1895.

The causes of this economy are, 1, steam jackets; 2, compounding; 3, reheaters; 4, and simultaneously with 1, 2, 3, higher steam pressure; 5, later combination of all the above with larger low pressure cylinders than had in general been used. While steam jackets date from the time of Watt, and the reheater from the time of Cowper, in the early sixties they had not in general been appreciated. At present there is a tendency to underrate them, but it is not to be forgotten that all of the good records are obtained from jacketed engines.

It is safe to say that from 1870 to 1895 steam consumption of engines has steadily decreased from 20 pounds to 12½ pounds per indicated horse power per hour. Other things being equal, this means a saving of coal of 37½ per cent. This has also carried with it a reduction in the number of boilers required of about the same per cent. Within this period of 25 years the use of exhaust steam for various purposes has extended, so that the steam power in mills of certain kinds costs almost nothing for coal. In boilers there has been scarcely any improvement in economy of the prevailing type, viz., the horizontal return tubular boiler. There have been some improvements in grate bars tending to promote economy.

The vertical boiler is receiving the recognition that it deserves, and it is likely to displace the horizontal return tubular boiler, as it saves about 4 per cent. of coal compared with the latter, and, besides, provides moderately superheated steam, which in itself is productive of economy. Vertical engines are beginning to be appreciated, and I predict their increasing use in mills from this on. Their friction is less than in horizontal engines by some 6 per cent., and thereby a saving of about this amount of steam is in sight. There is also the economy which results from the use of economizers in the flue, and in the general case this saves 7 or 8 per cent. of coal; but as this is something extra, compared with the older plants, the fixed charges that go with this should be considered. They probably reduce the net saving in money to 4 per cent.

The remaining improvement that is now apparent, except the continued increase in steam pressure, which will soon reach 200 pounds, is superheated steam. There is now no difficulty in using this, as we have oil that will stand its use in cylinders. By its use a small engine has used 10.17 pounds of steam per 1-horse power per hour, and it would seem that 10 pounds were within reach. Ten pounds can be compared with 12½ pounds, giving 20 per cent. saving over the best present practice. Finally, it should be remembered that the modern plant is not the most economical that can be installed at present, but far from it. Similar remarks can be applied to the plant of 1870. Now, looking a little further into the future, for the common use of highly superheated steam and its effects, it can without doubt reduce the consumption of steam to 10 pounds per horse power per hour. Steam sufficiently superheated to do this is perfectly practicable to day, and is used in a few plants in Europe. It has not been applied, however, to any high grade engines.

Moisture in Coal.

Engineering Record remarks that the characteristics of different coals with reference to their ability to absorb moisture vary between wide limits. Anthracites are almost wanting in this property. The surfaces of the lumps of anthracite coal become wet when exposed to rain, but there is scarcely any penetration of the moisture into the structure. The semi-bituminous coals, of which the Cumberland and Pocahontas are examples, absorb some moisture because a considerable portion is usually in the condition of dust, but the part which consists mainly of lumps absorbs little more water into the body of the fuel than does anthracite coal. If a small pile of Cumberland coal which has been wet by the rain is left in the open air, the moisture will quickly and almost wholly disappear after one or two days' drying. The percentage of moisture which these coals contain when subjected to the ordinary exposure of transportation and storage in an unprotected pile seldom reaches as high a point as 5 per cent. The bituminous coals have different properties in this respect. Their power of absorbing moisture is much greater. Some of these coals which have all the appearance of being practically dry will, when tested for moisture, shrink 5 per cent. or more. The water enters the structure and becomes in some degree hydroscopic. The surface indications fail to reveal it. These coals sometimes contain no less than 15 per cent. of moisture, and yet they appear no more moist on the surface than Cumberland coal, which holds but 5 per cent.

It is a matter of some concern how to treat the moisture in the case of wet coal used on an evaporation test. It is agreed that the basis of computation should be the weight of dry coal, but the point at issue is whether the boiler should be given credit for the evaporation of the moisture in the fuel. The subject does not have the importance with the higher grades of coal because these seldom contain much moisture. As it happens the coals which contain the large quantities are the ones which are often of the poorest class. With an evaporation, for example, of 5 to 1 and 15 per cent. moisture in the coal, the credit to which the boiler is entitled for evaporating this moisture is 3 per cent.; whereas, in the case of the high grade coals giving, perhaps, 10 to 1 evaporation, with 5 per cent. moisture, the percentage is only one half of 1 per cent. It would appear, then, that the subject might in some instances be of great importance.

How this should be decided is a question depending upon the object in view. If the commercial value of the coal is the thing desired and the moisture is one of its usual characteristics, then no allowance of any kind should be made for it. The moist condition is the state in which it is purchased, and that is the condition on which the results should be based. If the efficiency of the boiler as a steam generator is desired irrespective of the coal used, it seems certain that the boiler should have the benefit of every advantage to be derived from the use of dry coal, and under those circumstances it should have the credit of evaporating the moisture which the coal contains the same as though moisture was in the interior of the boiler. The boiler should in no respect be made to suffer because of the heat lost in this way.

The Market for Gas Securities.

Something of a drive was made to-day (Friday) in Consolidated, certain bear operators having, through a judiciously put out line of short stock, succeeded in marking the price down to 164¾. Early in the afternoon sales were made at 165¼, with that figure bid for more stock. It looks a very nervy thing to sell Consolidated short; for our part we would rather buy it for long account at 175 than sell it short at 164. Our advice is to buy and to buy with the expectation of holding until the deal is made. East River common crossed the 80 mark, and other city shares are dull and strong.

Brooklyn Union is in fair demand, at a shade lower than a week ago. Chicago gas is steady. The details of the merger in Chicago's gas interests are to all intents and purposes arranged. Bay State is uncertain and erratic. Laclede common advanced to 27. The general situation is in favor of the investor.

Gas Stocks.

Quotations by Cochran & Close, Brokers and Dealers in Gas Stocks.

35 Wall St., New York City.

July 12.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$35,490,000	100	164¾	165
Central	500,000	50	195	..
" Scrip	220,000	..	100	.
Equitable	4,000,000	100	222	225x
Bonds, 6's	1,000,000	1,000	105	.
" 1st Con. 5's	2,300,000	1,000	114	.
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	242	245x
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	.	..	.
Northern	150,000	50	85	
" Bonds	150,000	1,000	..	98
New York and East River	5,000,000	100	79½	80½
Preferred	2,000,000	100	111¾	112½
Bonds 1st 5's	3,500,000	1,000	112	115
" 1st Con. 5's	1,500,000	..	106	107½
Richmond Co., S. I.	348,650	50	50	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	110	111¼
Preferred	5,000,000	100	117	..
Bonds, 1st Mortgage, 5's	1,500,000	1,000	113	116
Yonkers	299,650	50	180	
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	109¾	110
" " Bonds (5's)	15 000,000	1,000	112	112¾
Bay State	15,000,000	50	12½	12¾
" Income Bonds	2,000,000	1,000	..	35
Boston United Gas Co.—				
1s Series S. F. Trust	7,000,000	1,000	87	.
2d " " "	3,000,000	1,000	61	..
Buffalo Mutual	750,000	100	125	..
" Bonds	200,000	1,000	95	100
Central, San Francisco	2,000,000	..	95	..
Chicago Gas Co.	25,000,000	100	93½	94
Chicago Gas Lt. & Coke Co. Guaranteed Gold Bonds.	7,650,000	1,000	104	104¼
Columbus	1,000,000	..	78	80x
1st Mortgage	1,085,000	..	..	96
Consumers, Jersey City	2,000,000	100	73	77
" Bonds	600,000	1,000	101½	103
Cincinnati G. & C. Co.	8,500,000	100	201½	202
Consumers, Toronto	1,600,000	50	184½	187
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Consolidated, Baltimore	1,000,000	100	..	57½
Mortgage, 6's	3,600,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490,000	..	..	..
Detroit	4,000,000	..	22	..
" Con. Bonds	4,312,000	..	72½	74
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	81	83
" Bonds	2,000,000	..	92	94
Hartford	750,000	25	..	145
Indianapolis	2,000,000	..	146	150x
" Bonds, 6's	2,650,000	..	104	106
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind.	1,000,000	100	82	84
Bonds	1,000,000	1,000	92	94
Louisville	2,570,000	50	..	..
Laclede, St. Louis	7,500,000	100	27	27¼
Preferred	2,500,000	100	82½	83
Bonds	9,034,400	1,000	100¼	..
Little Falls, N. Y.	50,000	100	..	100
Bonds	25,000	..	..	100
Montreal, Canada	2,000,000	100	200	.
Newark, N. J., Gas Co.	1,000,000	..	142	..
Bonds, 6's	4,000,000	..	123	..
New Haven	1,000,000	25	225	..
Oakland, Cal.	2,000,000	..	53½	54
" Bonds	750,000	..	..	..
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,00	1,000	..	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	..	175
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	88	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10.000,000	100	94	94½
St. Paul Gas Light Co.	1,500,000	100	79	81
1st Mortgage, 6's	650,000	..	84	87
Extension, 6's	600,000	..	..	..
General Mortgage, 5's	2,400,000	.	88	90
Syracuse, N. Y.	500.000	25	..	..
Washington, D. C.	2,000,000	20	250	..
Western, Milwaukee	4,000,000	100	71	72
Bonds, 5's	3,556,000	.	98	100
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DIVIDEND NOTICE.

OFFICE OF THE UNITED GAS IMPROVEMENT CO., 813 DREXEL BUILDING, PHILA., June 24, 1897.

The Directors have this day declared a quarterly dividend of 2 per cent. (one dollar per share), payable on July 15, 1897, to stockholders of record at the close of business June 30th. Checks will be mailed.

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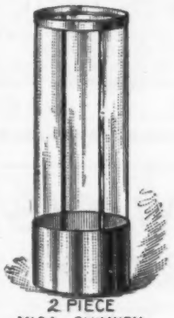

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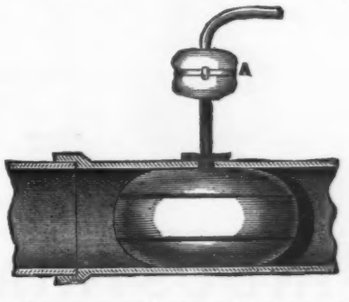

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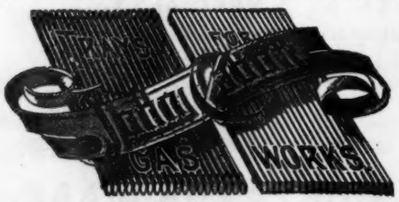

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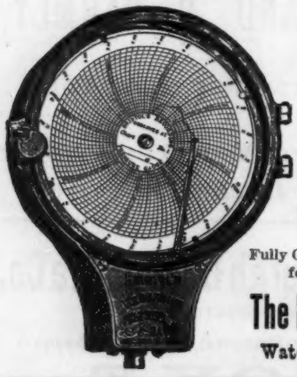

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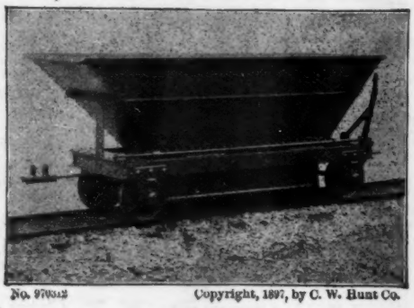

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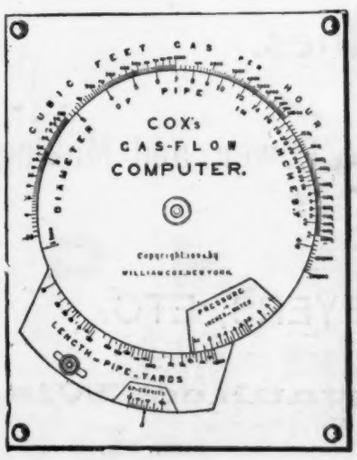

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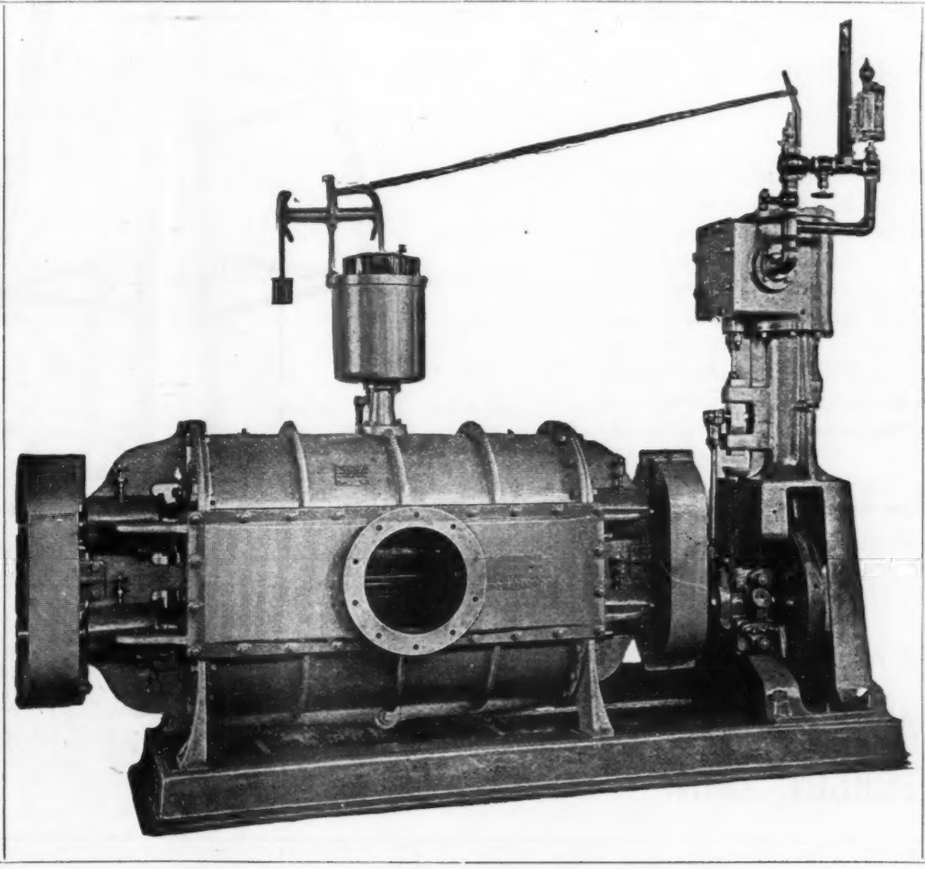

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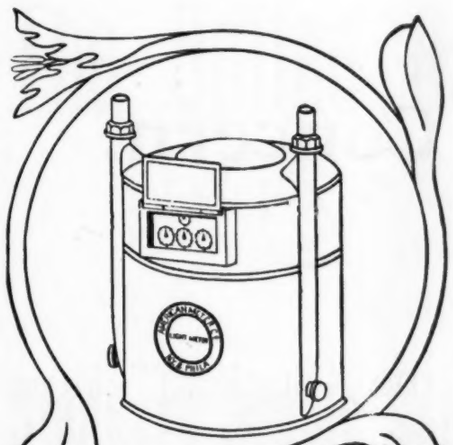

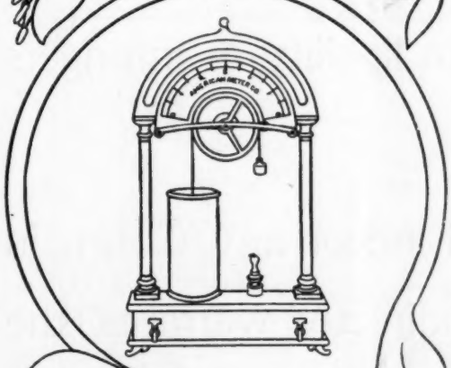

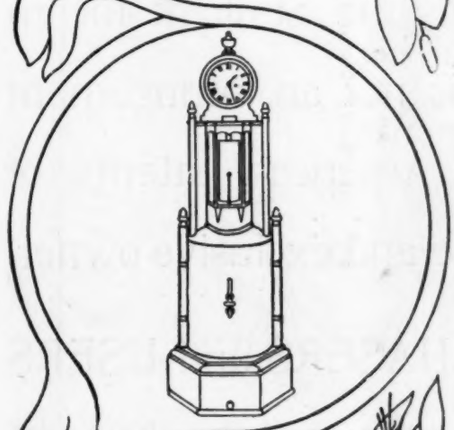

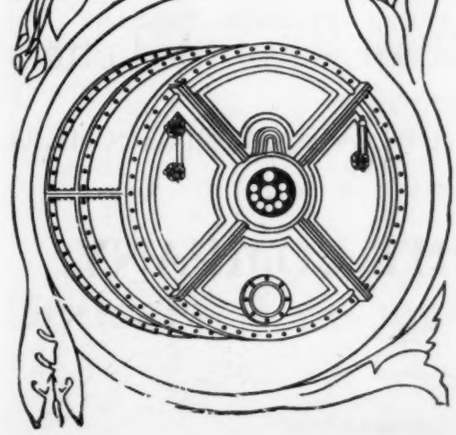

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NEW YORK AND PHILADELPHIA,

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SAN FRANCISCO.

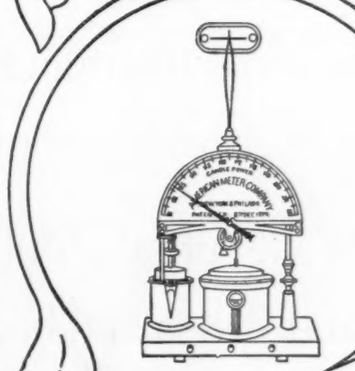
PUBLIC LIGHTING TABLE.

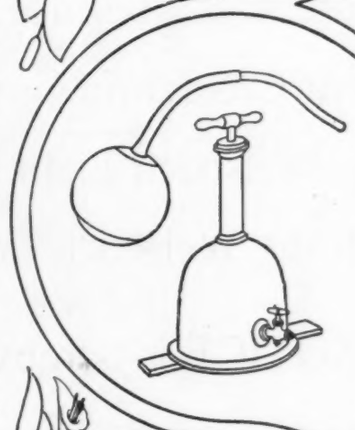
JULY, 1897.

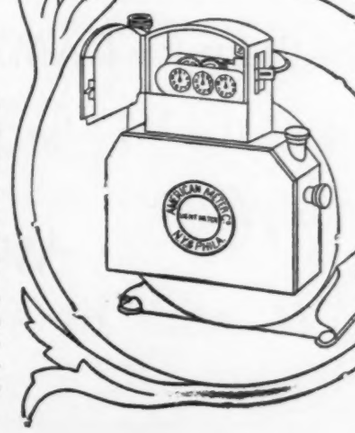
Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguist.
				P.M.	A.M.
Thu.	1	8.00 PM	3.30 AM	7.30	3.15
Fri.	2	8.00	3.30	7.30	3.15
Sat.	3	8.00	3.30	7.30	3.15
Sun.	4	9.10	3.40	7.30	3.15
Mon.	5	9.40	3.40	7.30	3.15
Tue.	6	10.00	3.40	7.30	3.15
Wed.	7	10.30 FQ	3.40	7.30	3.15
Thu.	8	11.00	3.40	7.30	3.15
Fri.	9	11.40	3.40	7.30	3.15
Sat.	10	12.30 AM	3.40	7.30	3.15
Sun.	11	1.30	3.40	7.30	3.15
Mon.	12	No L.	No L.	7.30	3.15
Tue.	13	No L. FM	No L.	7.30	3.15
Wed.	14	No L.	No L.	7.30	3.15
Thu.	15	8.00 PM	9.30 PM	7.30	3.15
Fri.	16	8.00	10.00	7.20	3.15
Sat.	17	8.00	10.30	7.20	3.15
Sun.	18	7.50	10.50	7.20	3.15
Mon.	19	7.50	11.10	7.20	3.15
Tue.	20	7.50	11.30	7.20	3.15
Wed.	21	7.50 LQ	12.00 AM	7.20	3.15
Thu.	22	7.50	12.30	7.20	3.15
Fri.	23	7.50	1.00	7.20	3.15
Sat.	24	7.50	1.50	7.20	3.15
Sun.	25	7.50	2.40	7.20	3.15
Mon.	26	7.50	4.00	7.20	3.15
Tue.	27	7.50	4.00	7.20	3.15
Wed.	28	7.50	4.00	7.20	3.15
Thu.	29	7.50 NM	4.00	7.20	3.15
Fri.	30	7.50	4.00	7.10	3.30
Sat.	31	7.50	4.00	7.10	3.30

TOTAL HOURS LIGHTING DURING 1897.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	233.00	January	423.20
February	187.20	February	355.25
March	202.00	March	355.35
April	170.40	April	298.50
May	163.00	May	264.50
June	140.40	June	234.25
July	151.40	July	243.45
August	167.30	August	280.25
September	174.40	September	321.15
October	200.00	October	374.30
November	205.20	November	401.40
December	220.10	December	433.45
Total, yr.	2216.00	Total, yr.	3987.45







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WE have learned that the makers of the "Sunlight" lamp assert that there has been a decision in the English Courts which saves them and their customers from liability as infringers of the Welsbach patents.

We assure the public there is no decision of any Court, in England or elsewhere, that directly or indirectly warrants the statement or inference that the lamp sold by the Sunlight Incandescent Gas Lamp Company of America is not an infringement of the Welsbach Light as made under the American patents, of which the Welsbach Light Company is sole and exclusive owner.

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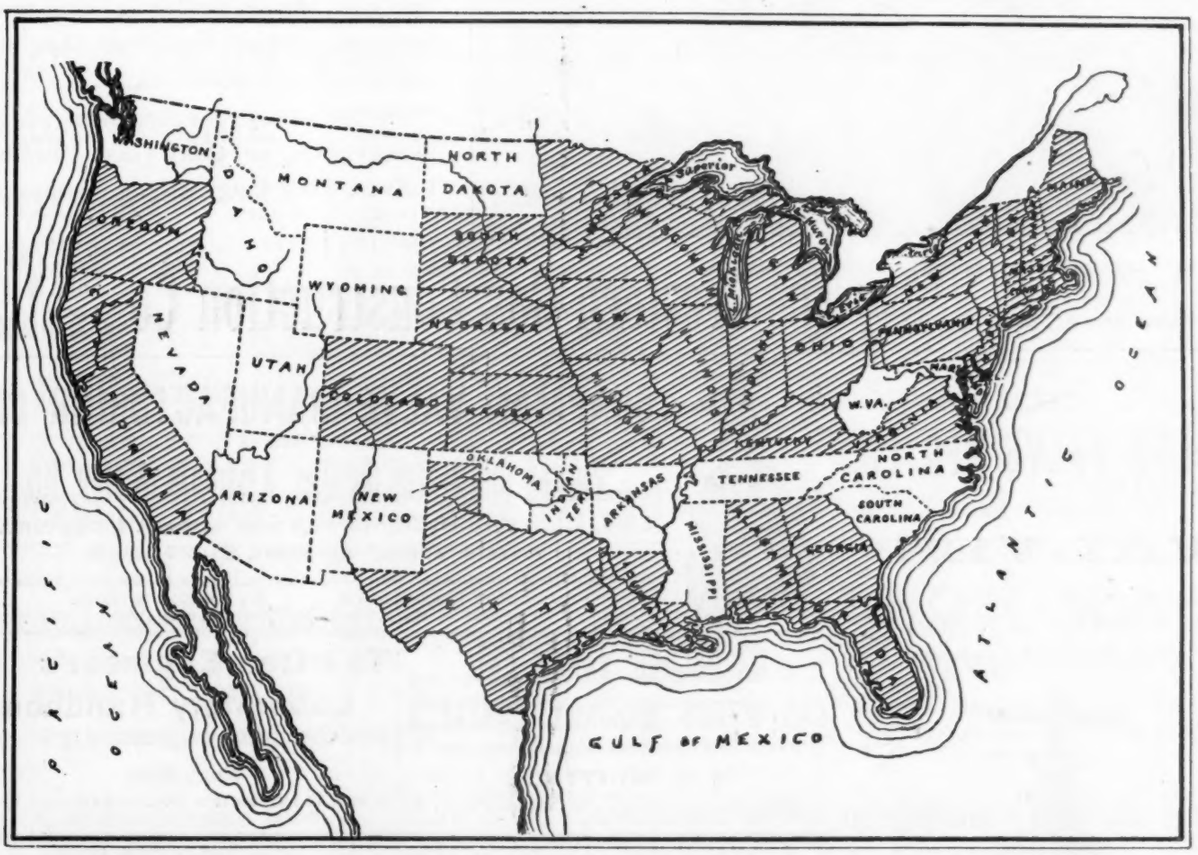

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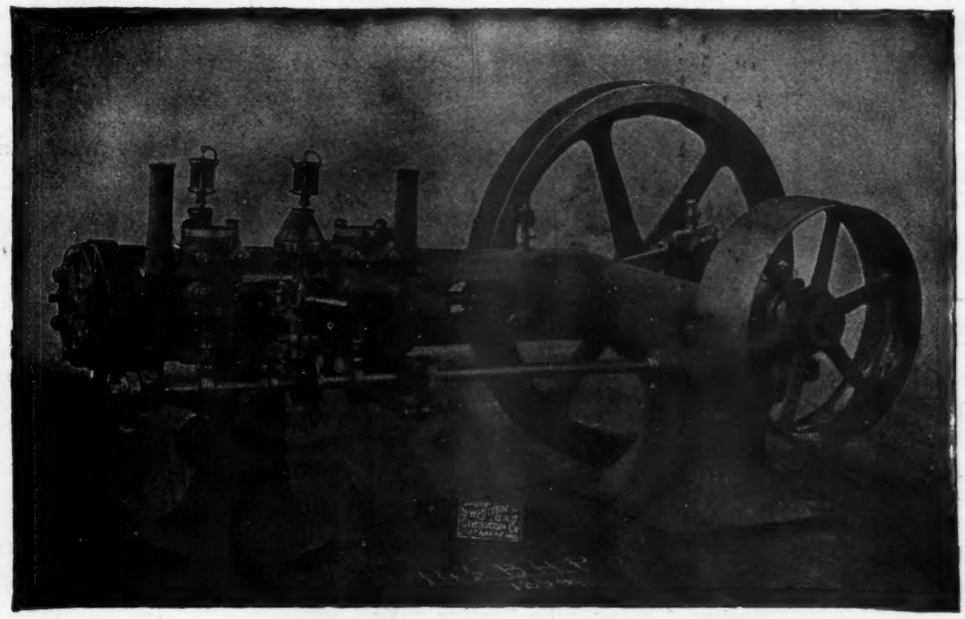

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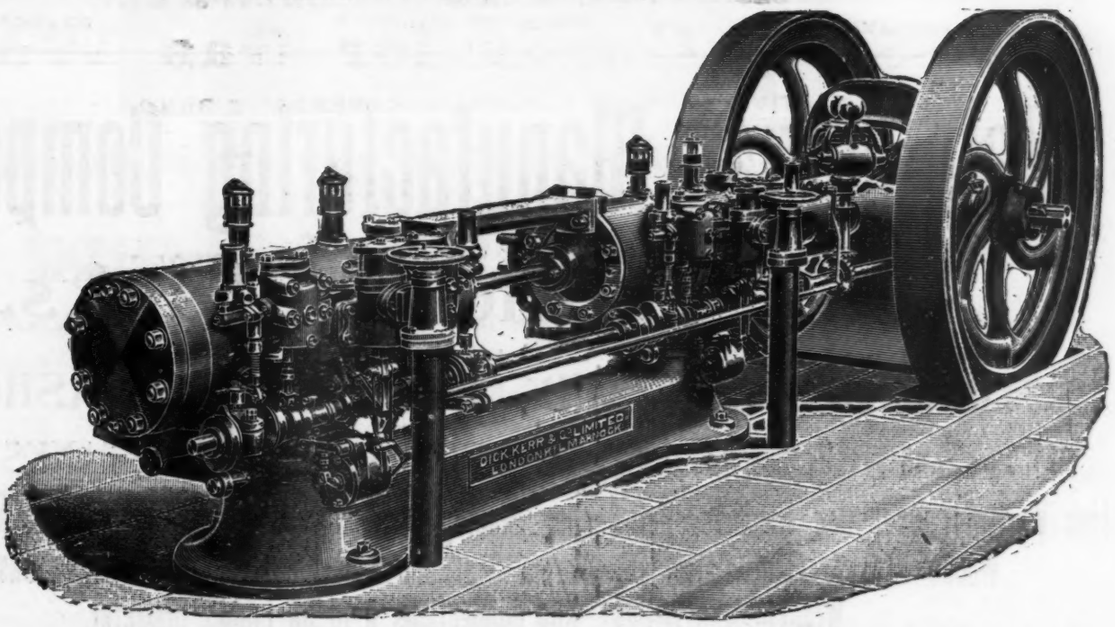

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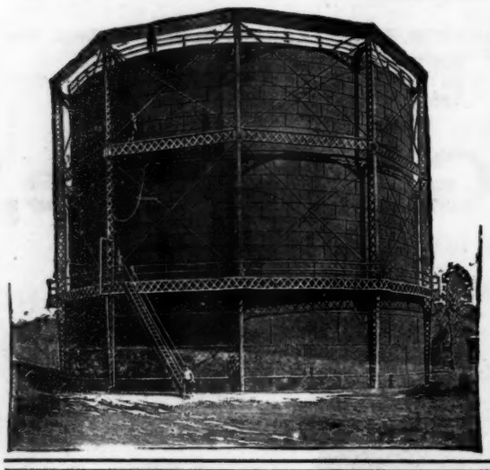

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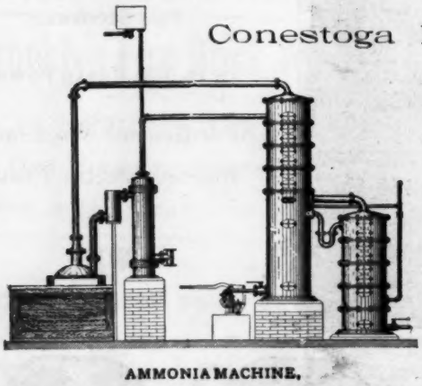

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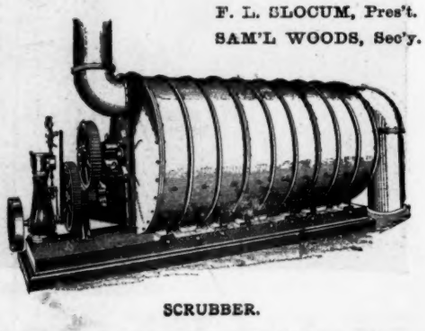

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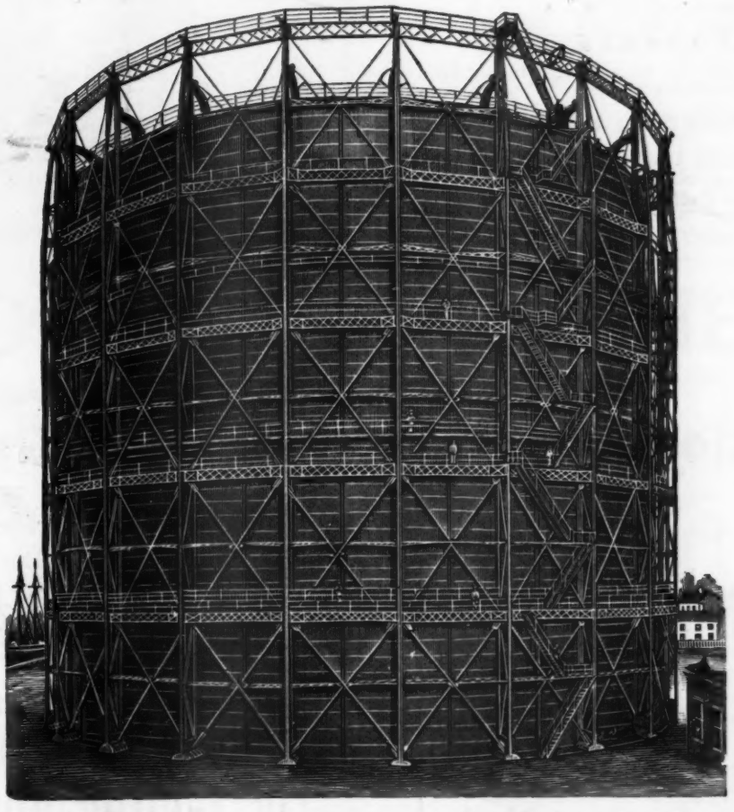

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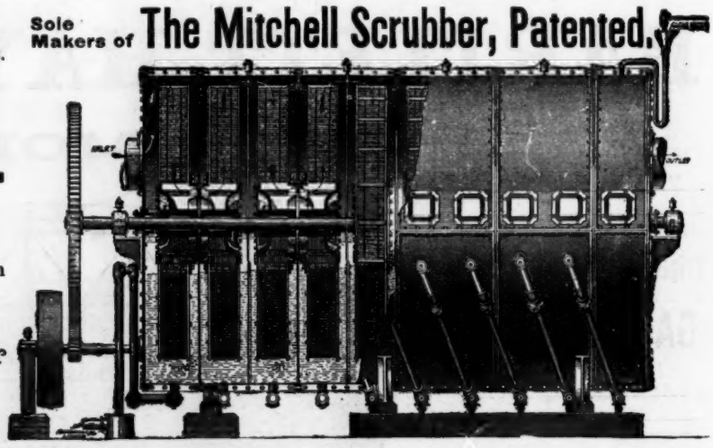

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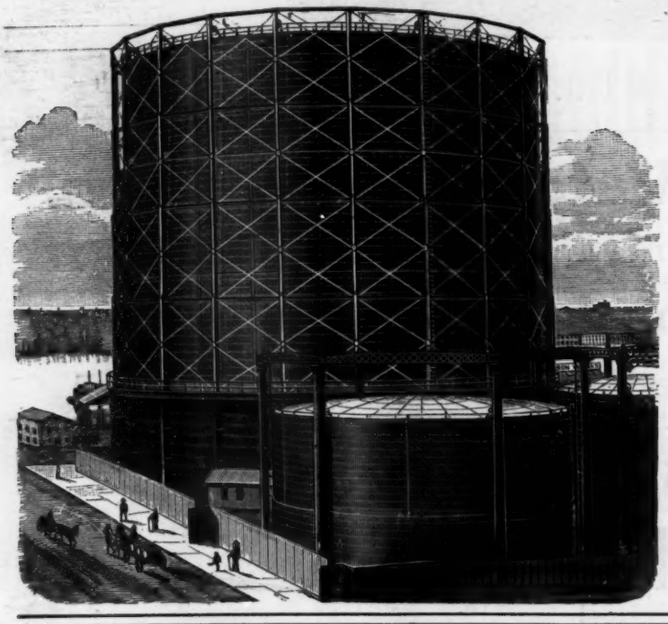

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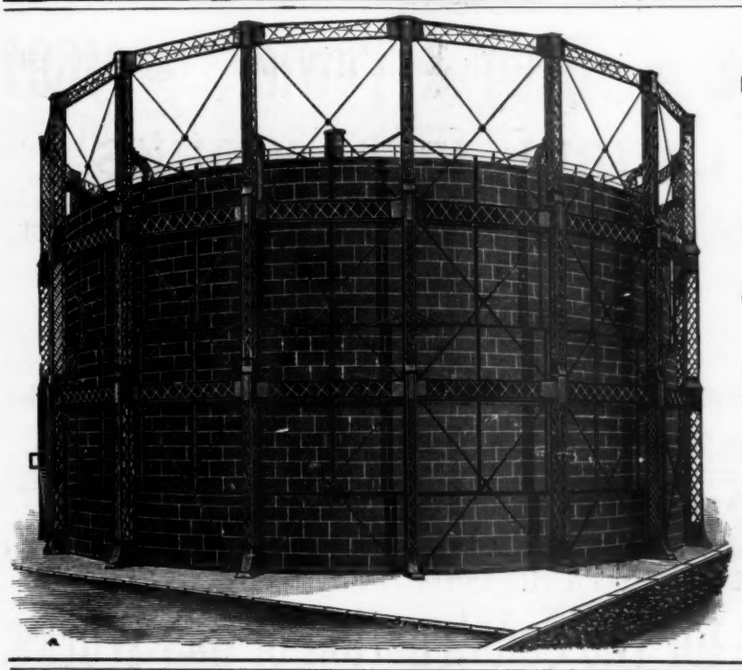

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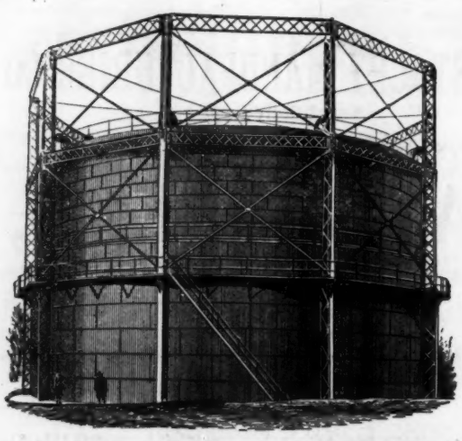

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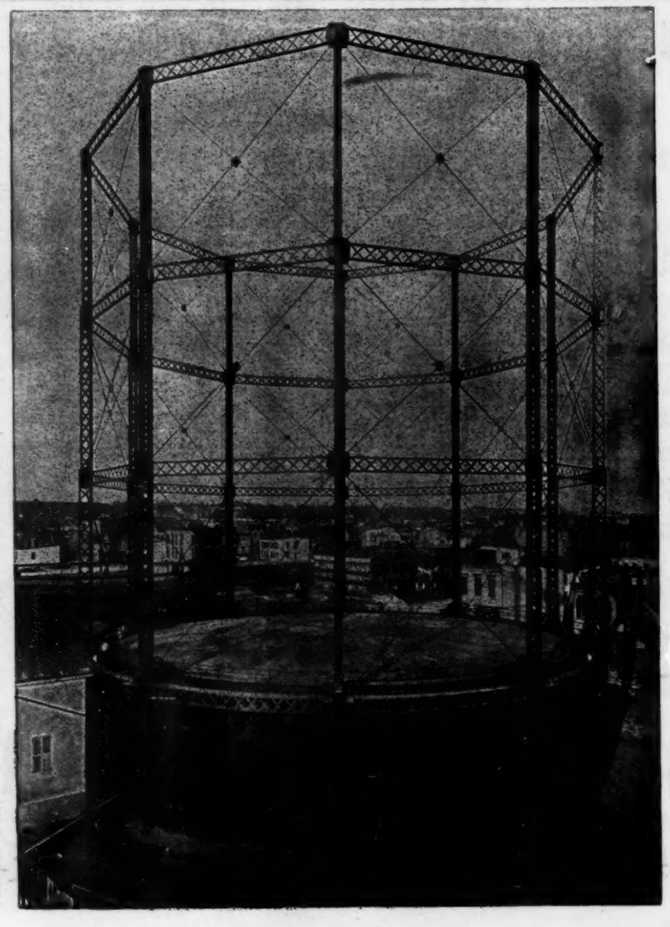

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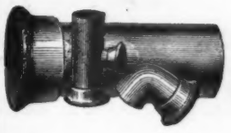

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